Dental Press

# Implantology

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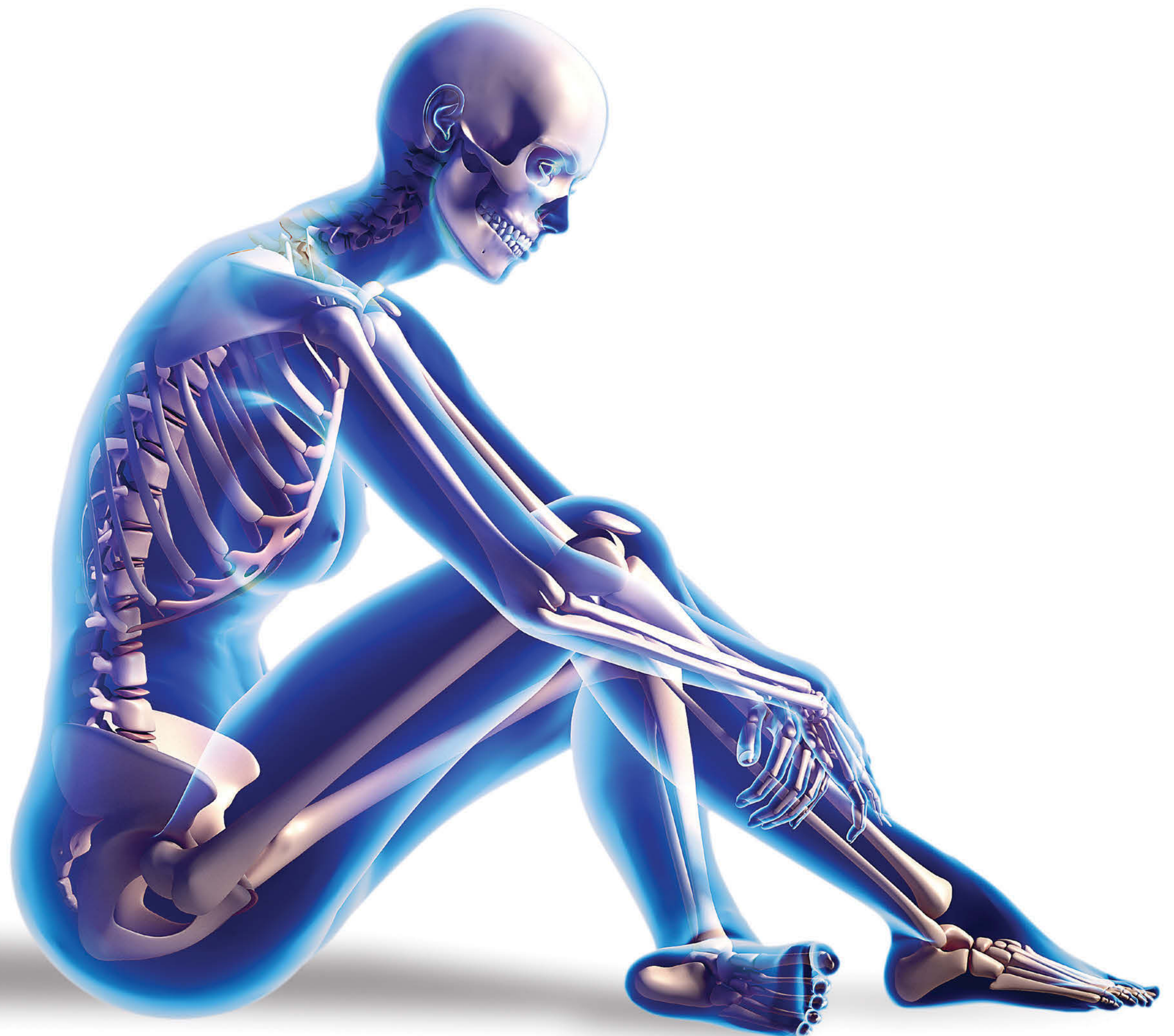

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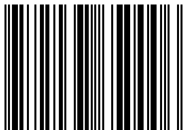

# Dental Press Implantology

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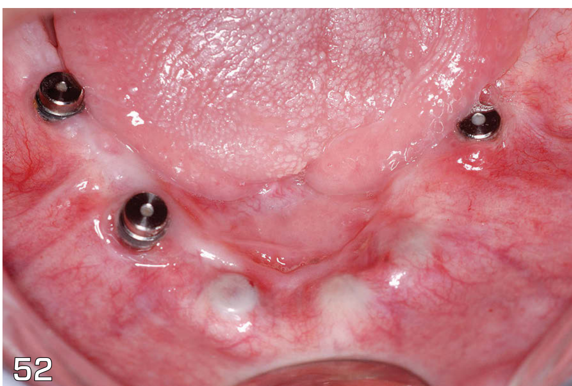

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# Ongoing renewal!

Every fifty years, pre-Columbian civilizations used to completely renew their methods and criteria for social and political organization, giving them a fresh new start, a new beginning, establishing a new cycle of progress during periods of renewal.

A scientific periodical has to follow the same path, cyclically renewing itself with new editors and advisers, new sections and new authors, new scientific and disclosure articles. This is what comprises any editorial dynamics around the world. By the way, "periodical" is strongly related to period, cycles!

Whenever a product was considered perfect and was fully accepted by its consumers, Steve Jobs would create new designs and a whole new product would be developed to replace it. When questioned why, he answered: "We have to practice autophagy if we want to keep our success. We cannot let our competitors do that for us. We have to do it before them!"

Research institutes and universities question, devise methods and criteria, employ them in their clinical and laboratory trials and, after discussing the results, present their conclusions in the format of an article.

Once completed, the research is published and that is when a new instance, which is not under the scientist's control, but under publishers' control, takes place. Those who write should not be the same people that publish, since this practice hinders selectivity. The editorial world of scientific journals should not be involved with the academic world. These two instances of science should not meddle! That is the reason why the advisors of a periodical are professionals with considerable scientific and academic experience, filled with articles and books, on which they base their decisions when selecting what other people wish to publish. They must be experts in research and publication.

And Dental Press Implantology has adopted such dynamism as well as other upcoming changes! For instance: What is the purpose of the interviews presented in a scientific journal? At first, they aim at giving the opportunity for the scientific community to know itself, in all of its facets, with its research groups, laboratories as well as researches and publishers. For a scientific journal evaluation board, the interviews are useless; but in Dental Press Implantology they fulfilled their role. And this was essential for Implantodontics, a new science whose practitioners came from Periodontology, Rehabilitation, Prosthesis and/or Surgery. It became necessary to know who embraced this new specialty and new research area.

Now that we know who and where we are, the systemic interviews will be replaced by new sections. Some interviews will be conducted in very special occasions, such as when a renowned researcher comes for a visit, internationally recognized research awards are received, or even when a creative and innovative businessman stands out.

New editors usually bring along new advisers, encourage the authors and try to give dynamism to the procedures of the periodical — always thinking of subscribers, advertisers and the best way to serve science, especially Dentistry. A journal is only apparently owned by a person; its real owner is the group of members of a certain scientific community!

Let the new come; and as the song says: "...it always does!"

In the context of renewing Dental Press Implantology, the current issue presents an example of attitude and conduct, the results of Prof. Dr. Paulo Perri's trajectory and thinking. Dr. Perri has elegantly contributed — with discretion and ethics — to the fields of Surgery and Implantodontics. His higher education and academic career were accomplished at the School of Dentistry — State University of São Paulo (UNESP)/Araçatuba, but nowadays, he is a professor and researcher of the School of Dentistry — University of São Paulo (USP)/Bauru and School of Dentistry — São Leopoldo Mandic/Campinas.

His trajectory reveals how a group must cohesively work on common objectives previously determined, explained and discussed by its members. Silently, Prof. Dr. Paulo Perri works with strong feelings of solidarity, fraternity and love for people, although not everybody is able to sense such feelings, always present in our daily lives. Happy are his students as well as his life and work partners!

Let us always reflect!
Alberto Consolaro

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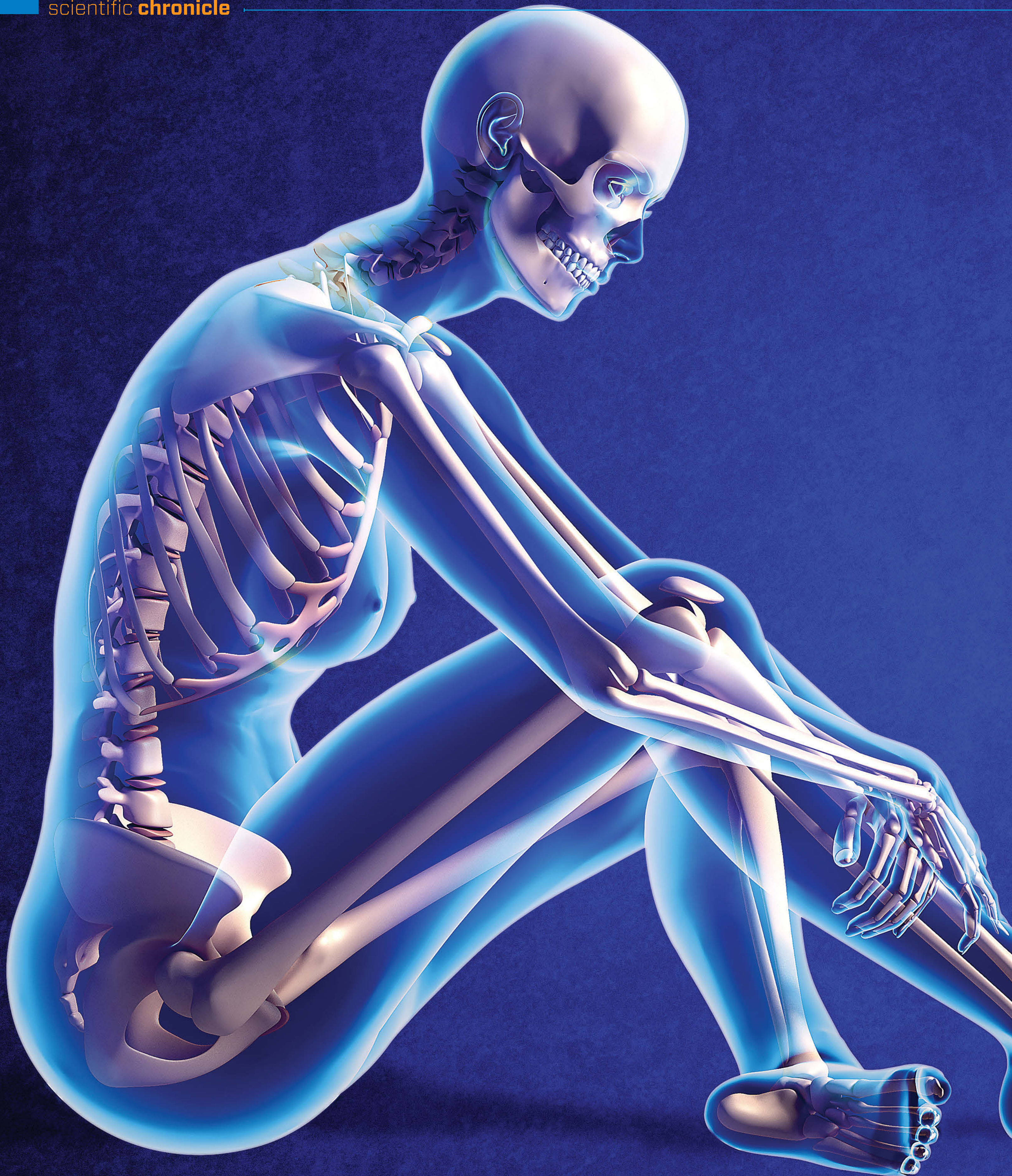


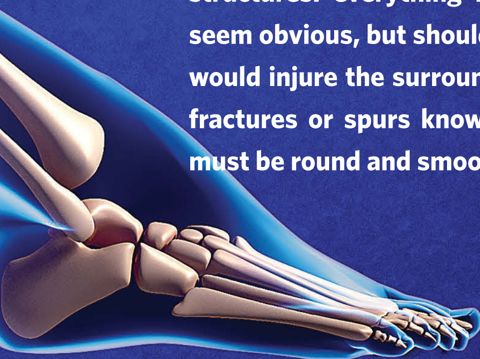
# The bone as a metamorphosis and the bisphosphonates!*

Alberto **CONSOLARO****

Raul Seixas, one of my favorite Brazilian singers, has continuously played in my iPod. One of his songs used to say: "I would rather be a wandering metamorphosis, than have the same old opinion about everything!" One of these days, a lady complained about the fact that her 35-year-old husband had left her four years before. After that, I heard that he had come back with an exciting talk: "Honey, I am back. Now, I am a new man, I have changed, everything is new!"

Although he was trying to deceive his lover, the man was right. The human skeleton has 206 bones, all of which are well and impeccably formed so as to meet our functional demands as well as absorb or exert forces when we move. Our bones, together with muscles and tendons, take us to every corner of the globe. If you go to a museum where human skeletons are displayed, you will see the shape of the bones, how they articulate or relate themselves with other parts of our body.

Our bones do not have corners, live edges or sharp structures: everything is smooth and round. It may seem obvious, but should our bones not be round, they would injure the surrounding soft tissues. People with fractures or spurs know how painful they are. Bones must be round and smooth.



Whatever is vital is protected by bones: the brain, heart and lungs, as well as the marrow that produces the liquid responsible for giving us life and defense: the blood. Bones are dazzling structures with many different variables: cartilage, tendons and joints. They even come in a gift wrapping paper: their outer surface has a resistant and protective membrane, the periosteum.

Athletes' bones are thicker and more mineralized, with adjusted structure and design. Conversely, sedentary people's bones are thin, less dense and less mineralized. We tend to consider the bones as hard and resistant structures. But, in fact, they are flexible, adaptable structures that meet all our functional demands. The skeleton is an excellent partner, but we usually ignore that!

How can the bone be like that? A skeleton of a young adult renews itself every 4-5 years, in other words, our skeleton is under continuous transformation. The husband was right, he did not lie when he claimed to be a whole new man. At least his skeleton had changed.

Let's make it clear: the brain does not renew itself, and that must be the reason why that stubborn is known as hardheaded, in which case it is not the bone's fault!

* Extracted and adapted from the book 'Queremos Saber' (We want to know), Ed. Idea, Bauru, 2013.

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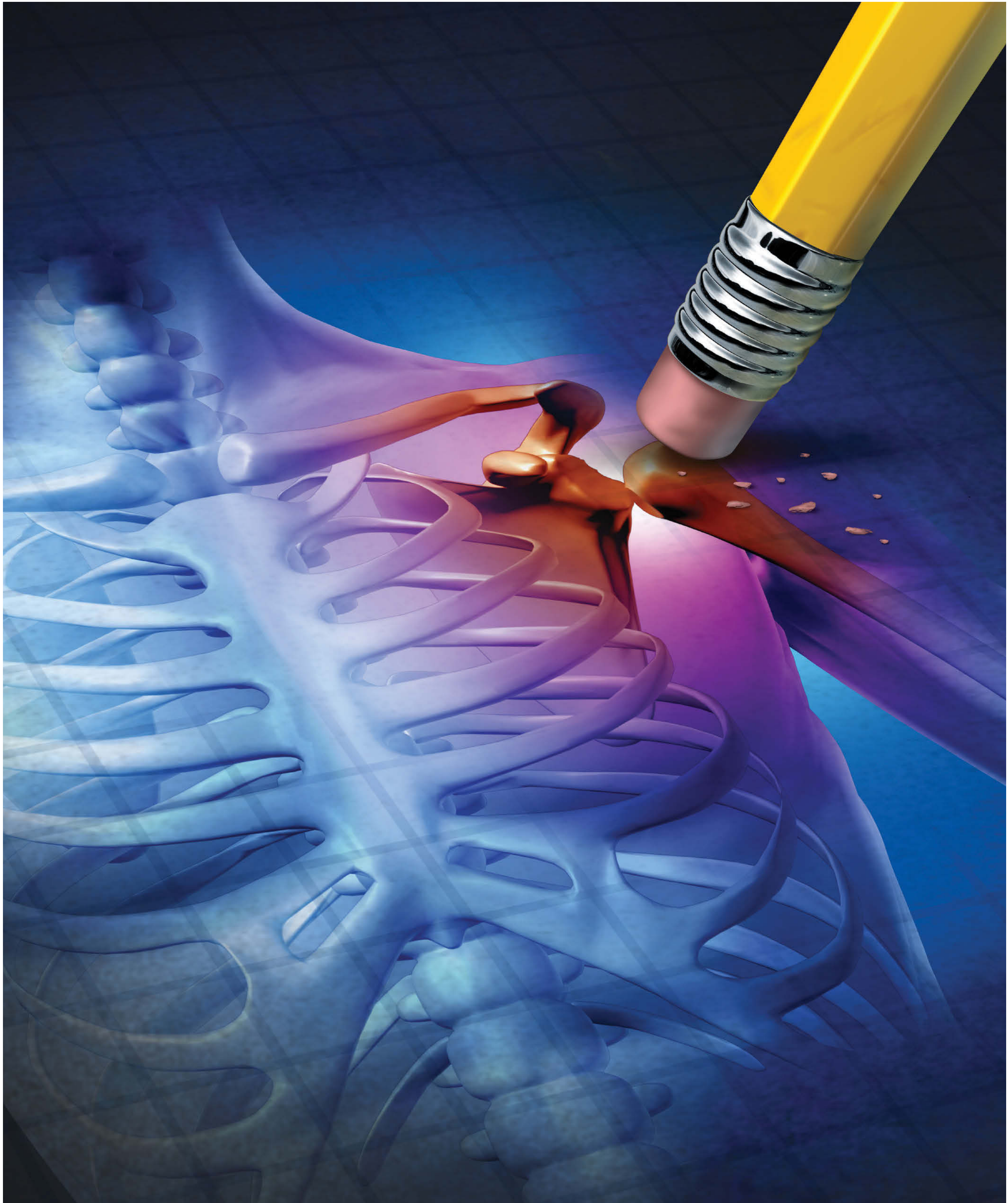

The mineralized bone structure has millions of tiny little lacunae as small as spider-shaped cells. The osteocytes have from 20 to 50 cytoplasmic extensions randomly distributed along the hard surface of the bone. Each one of these cells are connected with more 20 to 30 cells. Try to imagine many spiders holding hands with more 20 to 30 spiders. The osteocytes form a network inside the bone. When we apply force while moving, a deformation process occurs due to stretching or compressing. The network formed inside the bone apprehends these changes in shape and immediately sends chemical products to the inner or outer surfaces with the following message: change your current shape; we need to adapt ourselves to the new situation, improve the design. Every day, bone design is adapted to use. A show of flexibility, adaptability and will to serve.

Bone surface cells resemble masons: the clasts demolish coatings and walls, whereas the osteoblasts build up and reinforce pillars and structures. Researches reveal that surface cells are more and more controlled by osteocytes. The same osteocytes scientists believed to be lost and isolated in the mineralized matrix: scientists were certainly mistaken!

If you wish to strengthen your skeleton, deform and stretch your muscles and tendons so as to deform and stimulate the osteocytes network to adapt its design as you wish! Should the osteocytes be discouraged and inactive, they will not be stimulated to renew the skeleton and adapt it to different lifestyles. Bones will become more and more fragile, less thick and less resistant: it is up to you to decide! Should you like it or not, at least your skeleton is a wandering metamorphosis! This process is known as bone remodeling or turnover.

Our machine is incredible: remodeling provides the blood with calcium, a vital ion. A balance is established in this wandering metamorphosis: blood calcium must be stable; the skeleton must have a structure that agrees with its function. What is hard as bone is flexible and adaptable; and balance arises of an ongoing and wandering metamorphosis! We always have a lot to learn with our body. It is incredible!

## Bisphosphonates and bone biology

Calcium is present in most chemical reactions and plays an important role in most functions performed by our body. New cells need it and are at risk of dying if its levels in the blood are too low or too high. When its levels in the blood are low, the parathyroid glands release into the blood a substance known as parathormone which enhances the release of calcium from the bones, resulting in a transfer of calcium from bone fluid to the blood. When its levels in the blood are too high, thyroid cells release another hormone, calcitonin, which hinders bone resorption and reduces blood calcium.

It happens during the entire day: levels of calcium increase and decrease as we go on with our lives. To hinder bone resorption, calcitonin counts on the help offered by estrogen.

When the normal function of parathyroid and thyroid glands is no longer fulfilled, there may be more or less bone resorption. Should it be beyond normal conditions, the mineralized bone structures known as trabeculae and cortical become thin and fragile. This condition is known as osteopenia. In this condition, bones are subject to fracture in tiny areas or as a whole, and should it happen, osteopenia with fracture is defined as osteoporosis.

In menopausal women, there is loss of estrogen, a hormone that helps calcitonin to hinder bone resorption. In this case, daily bone remodeling is sped up, given that one of the elements that controls or hinders it, the estrogen, is absent. Women's skeleton may present osteopenia or even osteoporosis.

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No consensus has yet been established with regard to the advantages and disadvantages of estrogen hormone replacement therapy. In the last few years, this subject has not been on focus due to the emergence of a group of drugs known as bisphosphonates. Millions of women make use of this medication to control or prevent osteoporosis. The type of bisphosphonates most widely used is the alendronate, under different trademarks.

Bisphosphonates reach the blood and easily combine with circulating calcium. Wherever calcium goes, the bisphosphonate molecule goes along, reaching the entire body within weeks. Women under use of bisphosphonates will never have bone calcium alone; it will always be followed by something else. When the clasts (bone resorption cells) absorb calcium, they also absorb bisphosphonates that promote or speed up apoptosis. Clasts that used to be found in large amounts in the skeleton subject to osteopenia and/or osteoporosis are now found in amounts lower than normal and remodeling reestablishes its normal flow, similarly to what happens to a non-fragile skeleton.

In other words, bisphosphonates prevent, reduce and even eliminate osteopenia and osteoporosis. Since millions of women use this type of medication, imagine all the money and financial interest involved. Laboratories that do not hold a patent seek other alternatives and continue raising doubts about the efficacy of bisphosphonates and spreading their potential side effects.

These are minor, occasional and questionable effects that include femur fracture, association with esophagus cancer and maxillary bone necrosis, especially when alendronate is used. Researchers with no commercial interests acknowledge that the benefits overcome the side effects.

After carrying out a number of studies, the FDA questioned the benefits of long-term use of bisphosphonates for more than five years. The main question is: How long should bisphosphonates be taken in order to prevent osteopenia and osteoporosis? Studies suggest that in women with high risks of fracture, the long-term use of bisphosphonates is more beneficial, in which case is worth taking the risk. When the risks of fracture are lower, the cost-benefit relationship must be carefully analyzed.

Should there be any doubts, ask your doctor how you should proceed, because some published work is opposed to many scientific reports and that is how science works: whenever there is truth, it is ephemeral and when it remains, it will always be questioned!

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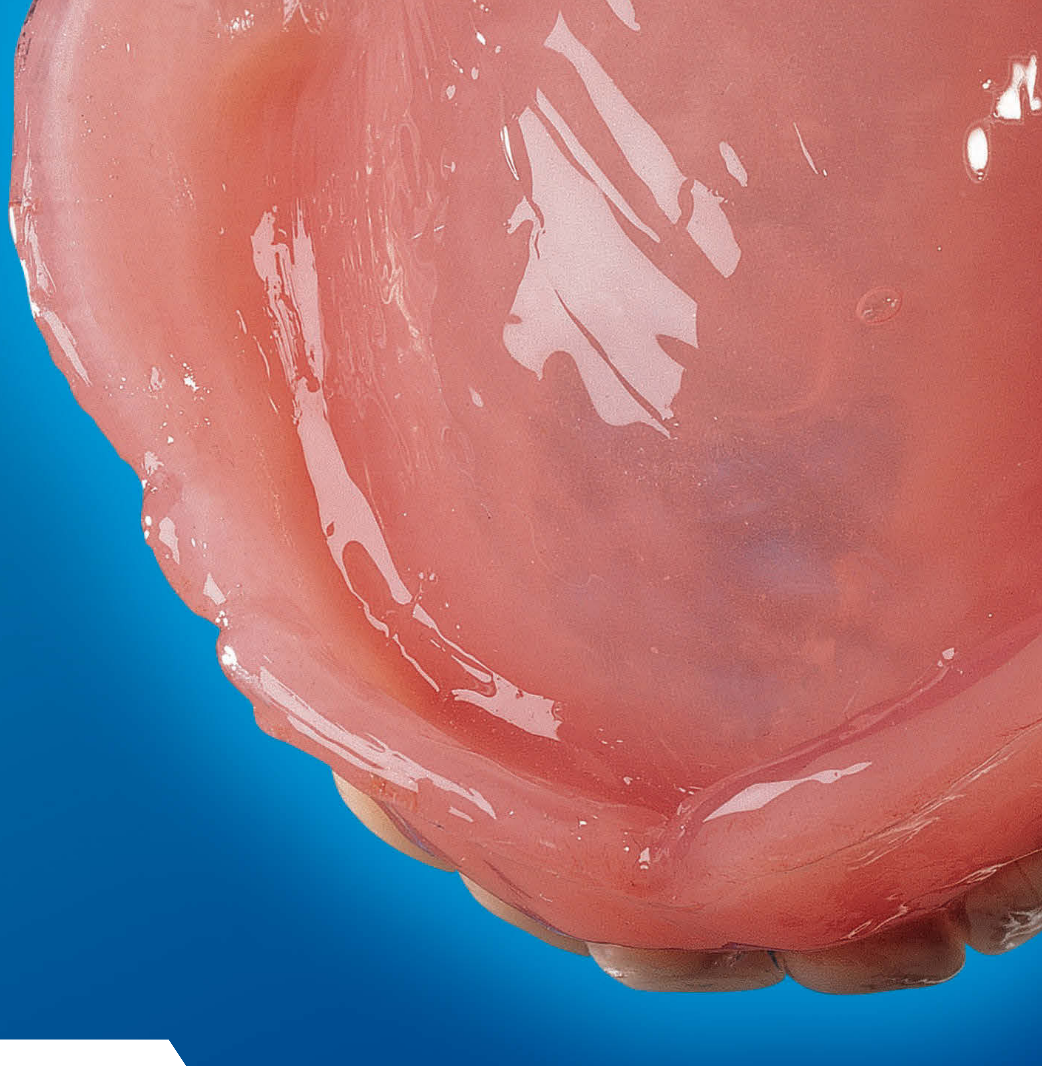

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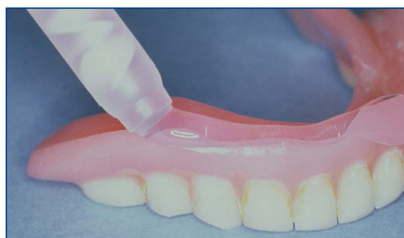

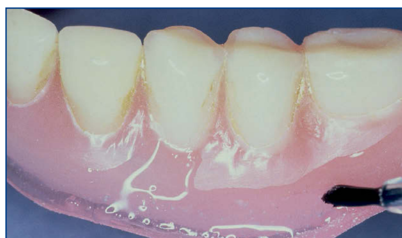

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# Paulo Sérgio Perri de Carvalho

Full professor at the State University of São Paulo (UNESP) and University of São Paulo (USP), Dr. Paulo Sérgio Perri de Carvalho has many qualities among which is his consistency in teaching classes with words strictly pronounced in a strong and invariable voice. Specialist, MSc, PhD and full professor of oral and maxillofacial surgery and traumatology, Professor Perri devotes 34 hours of his week to his academic career. For this reason, he is oftentimes found on Marechal Rondon road, where he goes from Araçatuba (his home town) to Bauru.

Dr. Perri devotes his spare time to employing his practical-scientific knowledge and treating patients at his private clinic where he can enjoy the company of his wife, Prof. MSc. Mariliza Comar Astolphi de Carvalho, specialist in Restorative Cosmetic Dentistry, Dental prosthesis and Periodontology. Throughout his brilliant career, he devoted himself to the study of bone tissue. Nowadays, he is seen as an authority on bone graft. Dr. Perri's great clinical experience in techniques for harvesting bone graft from the skull has enabled him to give theoretical classes that are well-provided with case and scientific reports previously investigated by him, which give a more realistic and precise tone to his explanations.

This interview gives us the opportunity to know about a dental surgeon who chose to make a difference by working as a professor, a researcher and a clinician, and in addition to that, by being a great person who goes from one dental specialty to another without further issues.

**Luis Rogério Duarte**

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Dr. Paulo Perri
CIR. BUCO-MAXILO-FACIAL

**According to deliberation 13, issued on the 17th of May, 2011 by UNESP, the academic career at the State University of São Paulo "Júlio de Mesquita Filho" has vertical and horizontal levels of progression. The vertical levels begin with a career as an assistant professor, move forward as an assistant doctor professor, adjunct professor and, finally, full professor, the highest position one can occupy. Since you graduated from UNESP, in 1976, you have devoted yourself to studying oral and maxillofacial surgery and traumatology, going for a Masters course one year after graduation. Did you aim at following an academic career and becoming a full professor since you received your degree in Dentistry? What did you expect from a full professor at that time and how do you see yourself as a full professor nowadays? Is there any difference from what you expected? Has any former professor been an example to you?**

When I was an undergraduate student, I was firstly interested in Pathology, a subject about which I conducted some studies under the supervision of Prof. Ronaldo Maia Melhado. However, as the clinical disciplines evolved, some of them stood out, as it is the case of Endodontics, led by Prof. Roberto Holland, and Surgery, led by Profs. Ruy do Santos Pinto, Tetuo Okamoto and my brother Prof. Antonio Cesar Perri de Carvalho. These disciplines stood out because the clinical procedures they taught were based on research and explanation, not on techniques that should be practiced. From that moment on, I became interested in the academic career, however, my aim was not to become a full professor, but a professor who taught a leading discipline and was involved in research as well as in evidence-based clinical application. In spite of that, I was aware that academic titles would come if I devoted myself to studying, researching and practicing the dental sciences.

The professors that taught when I was an undergraduate student used to have a "romantic" idealism, with fewer duties and less demand; differently from what happens nowadays, when professors also have to deal with many administrative issues. From a hierarchy point of view, in old times, talking to or questioning a full professor was a privilege of a few, which nowadays is indispensable, given that more experienced professors can do a better work when dealing with the wide variety of university students.

With regard to my expectations, they have been completely fulfilled. This may have been due to the fact that my older brother was a university professor in Araçatuba and, for this reason, I had the opportunity to closely experience what it was like to be a university professor, with the difference that I have always been more restless with regard to the limits that the academic career has imposed, including the activities performed outside the university.

As I have mentioned before, I had the opportunity to follow the example of many professors who taught the disciplines with which I worked until February, 2013. I tried to follow their example while building my own academic personality, but working with my adviser Prof. Tetuo Okamoto as well as with my brother, Prof. Cesar, were certainly more determining. Additionally, working with Dr. Ruy dos Santos Pinto, founder of both the Surgery postgraduate program at the School of Dentistry — State University of São Paulo/Araçatuba and the CAOE (Center for Exceptional Patient Care); Prof. Edmur Callestine, Prof. Márcio Giampietro Sanches, my partner in class and surgery procedures; Prof. Michel Saad Neto and, recently, Prof. Osvaldo Magro Filho and Prof. Idelmo Rangel Garcia Junior, was of paramount importance. Not only could I learn with each one of these professors, but I also had the opportunity of sharing academic experiences with them.

**The position of full professor can only be occupied by someone with experience in teaching and research. As a full professor who has been working in two of the most important Brazilian universities, what are the differences in responsibility between a full professor and an assistant PhD professor?**

Full professors aim at leading a team, fulfilling this function as positively as possible by encouraging and discussing with their group about the wishes and opportunities of each member. They have to provide, create or demonstrate equal opportunities for all members of the team while recognizing that these opportunities will be taken differently according to the potential, academic and emotional moment of each member.

According to each university code, a full professor has administrative duties that can only be performed by other professors, for instance, those who occupy a management position, in case of formal renunciation. Some universities, however, accept that these duties be performed by a doctor professor.

Thus, the difference between a full professor and the other professors is that the former position is usually occupied by more experienced professionals who should use their position to establish a balance as well as to positively lead their team without limiting or hindering one's progress.

**As an educator, you play an essential role in motivating and encouraging students to seek knowledge. What do you consider to be the most essential point of any university training students to be restless and critical towards the decisions they have to make?**

The most essential point is undoubtedly encouraging the search for knowledge, which science has proved to be unlimited. When Socrates, the philosopher, was considered the most wise man in Greece, he professed: "The only true wisdom is in knowing you know nothing." In other words, he makes evident that the more we know, the more we must be aware that we always need to learn. Researchers need to be humble about science. On the other hand, Pope Francis, during his recent visit to Rio de Janeiro, said that the young need to be revolutionary. He did not mean revolutionary in the sense of being violent or aggressive, but in not being a conformist. Thus, training professionals to be restless means letting them think that they do not own the truth, that there is a long way ahead of them to be followed in the search for knowledge. Additionally, it means letting them think that they cannot be conformists and believe that everything will naturally happen in their academic life, but that they have to find the answer for their questions and that is what comprises the different areas of knowledge. As for criticism, it is achieved by continuous and reflective study, although it may vary according to how mature students are. The educator must interpret these individual nuances and promote a series of educational as well as motivating actions in order to develop students' criticism.

**Your intense scientific production is one of the most remarkable characteristics of your career, demonstrating deep devotion to teaching and to the university itself. However, you never stopped treating your patients, you have always continued with your clinical activities at both the university and your private clinic. Could you, please, give us some examples of scientific evidence applied to surgical procedures and which are frequently used in your surgical practice?**

My first contact with Implantodontics was in 1989, during the training course for the TF system, in Rosario, Argentina. During the course, we had the chance to watch a series of surgeries performed for implant

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placement, and the first doubt I had was about the drilling procedure, given that we had published an experimental study demonstrating that the rotary instrument injured the bone surface and the repair of bone cavity was impaired according to the type of trauma received. When I returned to Brazil, I searched for studies that investigated the theme, but little data was found about the subject. That was my first research on Implantodontics, in which we assessed the action of milling cutters on rabbits' fibula with and without irrigation. Subsequently, we conducted a research on implant placement after drilling with and without irrigation. The results demonstrated that implants installed with drilling without irrigation did not osseointegrate. For each doubt I had, I developed an experimental trial with the material we had available in Brazil. The outcomes of such researches gave me confidence and knowledge of how to employ Implantodontics in my clinical practice. The same happened with bone graft and biomaterial. And that is my routine. I clinically employ the techniques and material that have been scientifically proved by my researches or by studies conducted by other researchers.

**There is a wide gap between scientific publications and the dental surgeon exclusively dedicated to the clinical practice. In other words, the number of professionals who seek knowledge in the source, in tested and strictly published researches, is limited. In your opinion, which changes can be made to the current publishing system in order to allow the scientific findings to enter into ordinary dental practice?**

There are many means by which one is able to seek knowledge: paper-based or online national journals, renowned international paper-based or online journals, national text books with excellent content, translations of international books, scientific events comprising different specialties, interviews, and others. To my view, there is never enough reading and studying! Most professionals in the Dentistry field appreciate a technique and limit themselves to using it without worrying about understanding its causes, longevity and potential complications. And why does this happen? Because most procedures are reversible. But, to my view, this is characteristic of our profession.

**The distance between scientific evidence and the dental clinic is a bilateral deficiency. Scientific evidence is not employed by clinicians at the same time that, with a few exceptions, the results yielded by treatments performed in private clinics are not published. How do you perceive such situation? Is it possible that, in the near future, clinicians will be involved with scientific investigation?**

Scientific studies developed in private clinics are nationally and internationally published. However, these studies are normally conducted by professionals who have been involved with postgraduate programs or research groups, they are not exactly a scientific investigation, but clinical results obtained from a registered procedure with previous scientific evidence. In the professional Masters I coordinate at São Leopoldo Mandic College, in the city of Campinas, I advise students to carry out retrospective studies based on the experience they acquire working in clinics and hospitals, and develop such studies into a thesis. With a treatment protocol in hand, it is possible to make comparisons, and after analyzing variables and samples, it is possible to develop a scientific publication.

**Soon after you received your college degree, you entered a Masters and a Doctorate program. Your knowledge about alveolar repair is of paramount importance nowadays. In Cosmetic Dentistry, every millimeter plays**

**a decisive role in determining treatment success and failure. Which alveolar alterations, in esthetic terms, can be expected by the clinician months after extraction?**

A few decades before osseointegrated implants, it was believed that implant placement with biomaterial delayed alveolar repair, in which case the best solution would be to fill the socket with coagulum. Such belief is still true, however, it has been proved that the alveolar process undergoes bone remodeling, more common with thin buccal walls in the anterior maxilla. This results in loss of the contour of the ridge and potential atrophic alveolar processes that hinder implant placement and esthetics. One of the treatment options for these cases is to fill the socket with biomaterial or place the implant immediately after extraction, filling the gap with biomaterial so as to minimize alveolar process remodeling. The duration of repair in cases of alveolar filling may range from 4 to 8 postoperative months. Although that option is available, there are cases in which connective tissue graft or the use of material incorporated to soft tissues is necessary to improve esthetics. Nevertheless, biomaterial is not recommended for all cases of alveolar defect. Autogenous bone graft is often used to reconstruct this type of bone defect.

**Some techniques have been exclusively developed to maintain gingival tissue stability and improve the gingival phenotype in order to establish predictability and maintenance of the regular concave arch. Other procedures recommend immediate implant placement with immediate loading or immediate implant placement associated with autogenous bone graft harvested from the tuberosity. Connective tissue graft and the use of biomaterial as xenograft are also reported in the literature. Extraction of maxillary anterior teeth is a difficult decision to make. What should we do? How should a dental surgeon decide which technique is the best? What are the main aspects to be observed during diagnosis before surgery?**

As I have previously mentioned, it is important to understand that biomaterial have some biological limitations. Thus, the professional must be wise when dealing with these cases. One should diagnose the type of bone defect as well as its cause, the periodontal biotype, the biological properties of the biomaterial to be used and the technical knowledge needed to solve the problem. Additionally, it is necessary to know the patients and how eager they are to cooperate.

**Preserving the alveolar process is important for treatment success and depends not only on the technique of preservation, but also on the technique employed to extract a tooth. In many cases, the time spent to extract a tooth is longer than the time necessary for immediate implant placement. What do you understand by atraumatic extraction? What are the most important surgical instruments you use for atraumatic extraction? In your opinion, is flap surgery sometimes necessary in the anterior region? In which situations?**

There is no atraumatic surgery. All types of surgery, whether complex or not, are somehow traumatic to patients. To define the best extraction technique, it is important to analyze the radiographic and imaging exams, identifying the root shape as well as its fragility and relation with adjacent teeth and anatomical structures. In order to perform extractions that are as atraumatic as possible, it is important to master the use of instruments such as forceps and periotomes. As for incisions made in the anterior region of the maxilla, they are recommended whenever the surgical instrument used for extraction cannot reach the site, in which case osteotomy is necessary. However, they should be

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economically performed to avoid impairment of the surgical procedure.

**Saucerization has been observed since the early stages of implant placement, when experiments were performed with dogs by professor Brånemark. Pericervical bone remodeling present in all implant and prosthetic connection models is a relevant factor to be considered in the medium and long-term maintenance of peri-implant tissues. Different prosthetic connection models, such as Cone Morse and platform switching, were developed to enable remodeling without bone loss. Which factors determine bone remodeling in this region? What are the advantages and disadvantages of Cone Morse and platform switching connections?**

Peri-implant bone loss is multifactorial, given that it may happen due to implant placement in bone tissue with limited thickness, poor revascularization resulting in tissue resorption as well as microbiological and biomechanical causes. Some studies reveal that the periodontal biotype may also be involved. In addition to these factors, local factors such as poor hygiene, tobacco smoking and some systemic diseases may aggravate the clinical presentation. It is difficult to establish a cause for peri-implant bone loss. The professional must be wise and use all diagnostic and information tools available to establish patient's profile and determine the most appropriate surgical-prosthetic planning that meets patient's expectations.

Some microbiological *in vitro* researches reveal that the advantages and disadvantages of Morse and platform switching connections include the barrier created by Cone Morse implants, which apparently hinders bacterial colonization in the prosthesis-implant interface. Conversely, the platform switching connection apparently removes this gap from the peri-implant site, preventing the bone tissue from being affected by the presence of bacteria.

Additional *in vitro* studies are being conducted with the photoelastic experimental model and finite element methods. They reveal that the forces occurring in the implants, whether Cone Morse or platform switching, are projected in a centralized manner, preventing stress from accumulating in the peri-implant site.

Thus, researches have revealed the biomechanical and microbiological advantages of Cone Morse and platform switching connections. However, clinical practice is absolute and, for this reason, it must prove such advantages by means of clinical prospective and retrospective studies.

**Patients who lost their maxillary posterior teeth often seek dental surgeons in order to have implant placement procedures carried out. As a result of a physiological process known as bone atrophy, the maxillary sinus cavity increases and, consequently, hinders implant placement before bone graft. Which are the available procedures employed to lift the Schneiderian membrane? In comparing auto and xenograft, what are the advantages and disadvantages of each procedure for the maxillary sinus?**

Sinus graft prior to implant placement is frequently performed by specialists in Implantodontics or Oral and Maxillofacial surgery. This type of surgery requires that the remaining bone and the dimension of the maxillary sinus be analyzed in the latero-lateral direction. In a book we published in 2011 (*Fundamentos da Implantodontia, Editora Quintessência*), we recommend autograft or autograft associated with inorganic biomaterial for

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5-mm remaining bone; biomaterial for 5 to 7-mm remaining bone and the Summer's technique for implant placement in case of 7 to 10-mm remaining bone. The last two recommendations require implant initial stability. Some studies have recently revealed that implants placed by means of the immediate technique, with stability, do not require the use of any filling material. As for the dimension of the maxillary sinus, its analysis is based on a research published in 2010, in which a maxillary sinus greater than 12 mm in the latero-lateral direction needs autograft associated or not with osteoconductive biomaterial.

In terms of the clinical results yielded by auto and xenograft, should the surgical procedure be performed without any accidents (for instance, laceration of the sinus membrane), in addition to a previous evaluation of patient's history (recent or current sinus pathology), the results are promising, with retrospective studies demonstrating success rates that range from 90 to 98%.

**In the anterior region of the maxilla, bone atrophy is present in height and width. For this reason and due to the fact that it is not a cavity, its reconstruction differs from the maxillary sinus. The use of particulate bone for this type of reconstruction presents considerable difficulty in stabilization, in which cases the use of block graft, screwed to the receptor site, is more common. Block autograft may be harvested from different intra and extraoral regions. If we consider surgical morbidity, tissue availability, graft quality and long-term volume maintenance, which is the best graft option?**

The best autograft is the corticomedullary one. Intraorally, oblique line graft is predominantly cortical, while the menton is corticomedullary. The difference lays in the postoperative phase in which the menton may present some undesirable complications. Both types of graft keep the volume in the late postoperative phase, however, the menton site presents greater bone availability.

**Intraoral donor sites are limited with regard to tissue availability. Should a large amount of graft be necessary for bone reconstruction, autogenous tissue can be harvested from extraoral sites. Could you describe the most common techniques, as well as their advantages and disadvantages, employed by Brazilian dental surgeons?**

The most common extraoral donor sites are the anterior iliac crest and the skull. The skull is advantageous for keeping the volume obtained in the postoperative phase for a long period of time, while the iliac crest loses in volume due to the dimensions of the trabecular space. Another advantage of the skull is its bone quality. Areas reconstructed with skull bone graft present type II bone, whereas those reconstructed with iliac crest graft present type III or IV bone. Nevertheless, the iliac crest provides blocks that enable an increase in height and width with a single block, which is not possible with skull grafts.

**Your researches reveal a preference for skull graft. The majority of the population, especially those with bone atrophy, comprises individuals who suffered a dental trauma when they were young. Implantology plays an important role in improving the image of one of the most feared professions. How do you deal with patients who feel insecure of treatment and to which you offer a technique of tissue harvested from the scalp?**

I never try to convince patients of the advantages of skull graft. Initially, I try to explain that a reconstructive surgery will be necessary to meet treatment expectations. Additionally, considering the patient's level of

atrophy, I also mention that a skull or iliac crest procedure will have to be performed in hospital. In any case, patients are impacted. However, when we mention the postoperative phase for each one of these approaches, the procedure performed in the skull seems to be more interesting. Many colleagues ask this question during courses or conferences. I have the impression that patients' acceptance is established by the professional's ability of explaining the need for graft and the advantages of a certain technique. A Master's thesis advised by me at São Leopoldo Mandic College, in the city of Campinas, reveals that all research subjects undergoing this type of procedure would recommend or be resubjected to the procedure of harvesting bone from the skull, if necessary.

**One of the disadvantages of autograft, whether intra or extraoral, is the need for a second surgical site. A common alternative, especially when a great amount of graft is needed, is the use of heterologous bone from musculoskeletal tissue banks. What is your opinion about the use of bone from tissue banks?**

I have no clinical experience with the use of bone blocks from tissue banks. I have followed both national and international publications, but what called my attention is that in 2010, JOMI (2010; 25: 525-531) published a systematic review on the subject and concluded that there is not enough evidence to establish the effectiveness of treatment comprising graft integration, ridge augmentation and implant survival. In 2008, Garbin Junior (PhD in Oral and Maxillofacial Surgery, State University of São Paulo — UNESP/Araçatuba) conducted a research in which he compared autogenous and homogenous grafts. He concluded that in late groups the autogenous bone had been replaced, while the homogenous graft had been integrated, was acellular and without remodeling.

**Some companies known for commercializing xenograft particulate bone have recently made block xenograft bone available. Do you consider it to be a feasible alternative for major reconstructions which have only been possible with the use of autograft bone?**

Similarly to my previous response, I claim to have no clinical experience on this subject matter. We have recently conducted the surgical phase of a research focusing on this type of material and we will have an answer for that soon. However, many colleagues have proved some clinical cases to be successful, even though the findings have not been published yet. Faverani (PhD in Oral and Maxillofacial Surgery, State University of São Paulo — UNESP/Araçatuba) conducted a research with mineral bovine bone block and concluded that graft performed with DBBM did not promote osseointegration.

**In the last ten years, the surgical techniques for implant placement have developed into procedures that do not require bone graft. The most common examples are zygomatic implants and the All-on-4 technique. Do you believe that all cases of edentulous maxilla may not require bone tissue augmentation by means of bone graft?**

The criteria for employing the All-on-4 technique are restricted to cases of pneumatized maxillary sinus. However, it may also be used in a more posterior position and when the patient relucts to accept sinus graft. Cases in which I employed such technique yielded satisfactory results.

As for rehabilitation of patients with atrophic maxilla and zygomatic implants, I recommend the All-on-4 technique to cases in which implant placement and autograft have been unsuccessful. I have followed the cases published by two colleagues who I deeply respect and who frequently use the aforementioned technique, Dr. Hugo Nary and

Dr. Paulo Saad. Their findings reveal an interesting success rate, provided that the technique is performed by experts based on careful planning and who are fully aware of the technique as well as of its difficulties.

Therefore, I am not radical to affirm that the need for autograft, used to solve the problem of atrophic maxilla, no longer exists.

**Many changes have occurred in the Dentistry field over the years of your career. Considered by the majority of the population as a traumatic profession, it has moved forward to a new position. Implantology has been in Brazil for more than 25 years and has changed the lives of thousands of patients whose confidence and self-esteem have been recovered. More recently, Cosmetic Dentistry has been concerned about treatment refinement and beauty. As a consequence, the dental surgeon has been given the role he deserves, acting as a professional of beauty and well-being. Which was the most motivating factor of your effort to have a solid career?**

My career began in oral and maxillofacial surgery and traumatology (a course I still teach for undergraduate students at the School of Dentistry — University of São Paulo/Bauru), and from 1989 on, I began my studies on Implantodontics. Raised in a school that aimed at answering the "whys" by means of experimental research, I began with Profs. Márcio Giampietro Sanches, Álvaro Bosco, Renato Rossi and my wife, Dr. Mariliza Comar Astolphi de Carvalho, a series of experimental researches on osseointegration of national implants, for instance, the *Sistemas Conexão* and Emfils ones. Thereafter, in 2000, Ariel Lenharo, Antonio Vicente Souza Pinto and Laércio Vasconcelos, all doctorate students, and I researched the immediate loading technique in both animals and humans. These researches, associated with experimental studies on biomaterial and the clinical practice began to be published in scientific events and, consequently, my career was built. Thus, my initial motivation fell on the need to study the new specialty that was being established in Brazil. The sequence of facts that would come was not only a result of a lot of team work, in which every member is of great value, but also of the interest in raising a responsible professional awareness by means of scientific knowledge and continuous studies on this specialty: Implantodontics which, when based on careful planning, can improve patients' self-esteem, masticatory function and, above all, make them smile.


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# Esthetic prosthetic resolution in Morse Taper platform

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**Abstract**

The issues arising from tooth loss in esthetic zones have been the subject of intense scientific dedication and clinical commitment of which purpose is to achieve favorable mechanical and esthetic stability. The advent of osseointegrated dental implants has satisfied the need for mechanical support; however, cervical bone remodeling around implants with conventional platform may significantly compromise the maintenance of peri-implant tissues, causing serious esthetic injuries. The purpose of Morse Taper implant placement goes beyond the current evolutionary trend in Implantology. It provides maintenance of peri-implant tissue characteristics and facilitates esthetic prosthesis design, thus allowing an ideal emergence profile and a natural and harmonious relationship with surrounding tissues to be achieved during the entire therapeutic process. Therefore, this literature review aims at presenting the characteristics that confer a high rate of success and longevity to prosthetic parts, ensuring greater predictability of maintenance in prosthetic rehabilitation.

**Keywords:** Morse Taper dental implant-abutment connection. Dental prosthesis.

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## Introduction

When Brånemark et al[1] described the process of osseointegration to rehabilitate totally edentulous patients, the objective was exclusively functional. With the development of implants, patients' requirements have increased and rehabilitation has become not only functional, but also esthetic.

The daily challenge faced by dental surgeons in the search for esthetical results leads to new parameters in which esthetical predictability is able to meet patients' demand. Some parameters that previously met functionality, now request other resources, such as prosthesis planning, tridimensional implant positioning, analysis of esthetic cost factors, diagnostic waxing, surgical guide, management of peri-implant tissues, and even computer-based planning such as CAD/CAM.[2]

According to Pereira et al,[3] treatment predictability results from careful and meticulous planning. In the past, professionals used to analyze where implant placement was possible, whereas, nowadays, assessment comprises the best prosthetic conditions to establish both function and esthetics, thus meeting patients' needs. This study was named as "reverse planning".

For Gomes et al,[4] esthetical and functional outcomes led Restorative Dentistry to seek new material and components in order to meet this new demand. The weaknesses of osseointegration were the implant/prosthetic and connection/artificial crown interfaces, both of which should not only provide a more natural appearance, especially in the cervical region where the prosthetic challenges are bigger, but also achieve esthetics of surrounding teeth and supporting tissues. Thus, the market for hexagonal, octagonal and triangular connections was replaced by internal conical connections.

Internal conical connections are widely known as Morse Taper. They have become a point of reference for esthetic prosthetic resolution. The Morse Taper system comprises characteristics of decreased bacterial contamination, minimized cracks in the implant/abutment interface, improved anti rotational stability and greater loosening torque in comparison to tightening torque.[5]

Peri-implant tissue support and connection stability are essential to preserve bone structure. For this reason, prosthetic alternatives, such as Morse Taper implants, were developed to meet the esthetic demands that could not be fulfilled by other types of connection (natural gingival contour and good prosthesis brightness).[6]

Therefore, this study aims at conducting a literature review in order to clarify the characteristics of the Morse Taper system prosthetic interface and its relationship with the esthetic results yielded by osseointegrated-implant rehabilitation.

## Literature review

### *The Morse Taper concept*

Stephen A. Morse developed a fitting mechanism that produces retention. It was used to manufacture mechanical tools and created to meet the need for retaining a bur or a mandrel inside cutting machines (drills, for example). The system acted by contact friction resulting from a male-female interface, and its effectiveness was increased by preload produced on the frictional surfaces, resulting in stability. This process coined the term "Morse Taper" in Implantodontics.[7]

Morse Taper connections allow prostheses to be produced with characteristics that closely resemble natural teeth, especially in esthetic zones. Its precise internal design provides close contact between surfaces and produces mechanical resistance similar to one-piece implants with no microgap, which results in greater horizontal force support, mechanical resistance and decreased stress points.[8]

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The prosthetic component is connected to a Morse Taper implant by its interface, given that prosthetic fitting cannot be achieved in the upper portion of the implant cervical region due to absence of a prosthetic platform. This fact allowed prosthetic components of identical design to be produced for implants of different diameters, thus decreasing the amount of components stocked in dental clinics. The central bore is the same for all implants, with only a few exceptions.[9]

The Morse Taper interface did not have an anti-rotational system of any kind. However, a prosthetic index has been recently added. It is particularly used to guide single-implant prosthesis placement with perfect esthetic fitting. Indexed abutments are screw-type connections that show the position of the prosthesis in relation to the implant and do not allow any changes in prosthetic placement.[9]

Morse Taper connections provide stability as a result of contact between the component's walls and the inner surfaces of the implant. For this reason, screws are less requested. Therefore, the internal conical connection provides better mechanical stability in comparison to implants with external hex.[3]

Morse Taper intermediate components have the screw and the prosthesis connected in one single piece. In spite of that, they must be analyzed differently: single or screw-type connections. The screw of screw-type connections is attached to the prosthesis, which prevents the surgeon from removing the screw that penetrates the intermediate component.[9]

Some Morse Taper systems adapt to the conical walls of the intermediate abutment through fastening the screw threads. The fitting systems, however, are adapted as a result of their conical shape. For this reason, they are known as pure or frictional tapers.

In esthetic zones, Morse Taper implants must be installed from 1 to 2 mm infraosseous so as to optimize and facilitate maintenance of tissues surrounding the implant cervical third. Insufficient amount of gingival tissue may lead to exposure of the retention system, which requires special components or customization of prosthetic abutment in order to provide rehabilitation that does not affect esthetics.[9]

## Indication and contraindication

Morse Taper connections are recommended for cemented single prostheses which, after application of torque following the manufacturer's instructions, hardly loosen. It is also recommended to replace lost teeth, especially in esthetic zones where long-lasting gingival esthetics is essential to keep a beautiful smile.[11]

Morse Taper connection yields positive results for immediate single implants. It is the first choice of treatment for immediate implants after extraction in low bone density areas with a high need for esthetic and functional outcomes.[12]

Placement of implants with Morse Taper connections is contraindicated for cases that involve high esthetic risks, patient's high expectations, high smile line, poor gingival quality, absence of papillae and low bone quality. In these cases, planning must include soft tissue graft or a different type of prosthesis. Significant angulation must be avoided.[13]

## Advantages and disadvantages

***Major advantages:***[11,14,15]

» No microgaps in the implant–abutment interface.
» Better transmission of forces at the implant-abutment interface.
» Better stability at the implant-abutment interface.
» Frictional retention with better distribution of forces at the inner walls of implants, which decreases physiological cervical bone resorption.
» Platform switching with prosthetic abutments of smaller diameter in comparison to implants.

» Immediate optimization for esthetic cases promoting soft tissue stability.

***Major disadvantages:***[14]

» Costs.

» Difficult technique.

» Low versatility of prosthetic components.

## Choosing a prosthetic abutment

According to Pereira,[3] gingival height and its relationship with the healing abutment previously installed must be considered whenever selecting a prosthetic component.

Misch[16] defined the neck of a prosthetic abutment as the limit between the prosthetic abutment crown and the portion attached to the inner part of the implant, which is completely inserted into the gingiva. In order to make a correct choice, three guidelines must be followed:[9]

***Diameter of the coronary portion of the prosthetic abutment***

The intermediate component must be 3.3 to 4.5 mm in diameter. The size of the crown must be taken into consideration, given that crowns of smaller diameter are usually used for anterior teeth.

***Neck height***

When choosing the prosthetic abutment, the distance between bone and gingival height in relation to the neck of the prosthetic abutment must be considered. The height of a straight intermediate component neck varies from 0.8 to 5.5 mm. In case of angulated components, it varies from 1.5 to 3.5 mm. Choice must be based on gingival height, and the following requirements must be met:

» Bone: radiographic examinations must be taken to assess the distance between the limits of a prosthesis and the bone crest. Such distance must be of at least 1 mm, however, 2 to 3 mm are acceptable whenever possible. This procedure aims at maintaining bone tissue through preserving the peri-implant biology as a result of care taken with the line of cementation.

» Gingiva: In esthetic prostheses, the emergence profile must be subgingival. For this reason, the intermediate component neck must be placed 2 mm below the gingiva. Given that the inner shape is the same, should the neck of the healing cap be too high, the gingival tissue will follow its pattern. Should the neck of choice be incompatible (too low), the intermediate component will exert excessive pressure on tissues, and the patient will feel pain by compression. Thus, it is recommended that the healing cap is equal in diameter to the intermediate component and in height to the gingival tissue. The height of the intermediate component must be compatible.

***Diameter of the coronary portion of the prosthetic abutment***

The coronary portion of the prosthetic abutment must be 4 to 6 mm in height, depending on the interocclusal distance.

In order to make a choice, the professional can use kits developed for this purpose or try to follow the references of use. The healing abutments previously installed must be considered. Neodent (Curitiba, Paraná, Brazil) developed a device to measure Morse Taper height, thus facilitating the procedures of establishing the height of a neck. The installation driver is connected to the hexagonal prosthetic index located below the Morse Taper system, which preserves the system walls and causes them to be touched by the prosthetic component, only.

## Prosthetic abutment with Morse Taper connections in esthetic zones

According to Pereira et al,[3] prosthetic abutments are also known as intermediate components, transgingival abutments or abutments. The manner by which an implant is related to a prosthetic component is known as prosthetic connection.[17]

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In order to choose a prosthetic abutment correctly, one must determine whether the prosthesis is cemented or screw-retained. Cemented prostheses are recommended to replace anterior teeth, given that they hide excess screw and, for this reason, can solve cases of non-ideal emergency profiles. They also allow the surgical location of an implant more closely related to tooth long axis, which results in more natural crowns. Screw-retained prostheses are recommended for cases to which reversibility is important. We should also analyze whether the prosthesis is single or multiple, the height and width of the interocclusal prosthetic space, the need for correction of angulation or parallelism between components, the height and quality of the transgingival tissue, as well as the distance from the limits of a prosthesis (line of cementation) to the peri-implant bone crest.[9]

Patient's esthetic requirements have led to the development of new components that not only aim at boosting resistance, but also at yielding better esthetic results. Considerable differences have been made in abutment shape, angulations, neck height, shape and material; all of which have been launched into the market and provided patients with a pleasant appearance for restoration procedures and peri-implant tissues. However, even though several types of connections and abutments are available, poor treatment planning, especially for the anterior region, may hinder esthetics.[3]

***Universal post***

There are single-body and screw-type universal posts. Single-body universal posts are one-piece components recommended for multiple prostheses and well-positioned implants. They facilitate prosthesis placement and eliminate the need for carrying out any adaptations, both in the vertical and cervical directions.[3,9]

Screw-type universal posts are recommended for cemented single prostheses. A nucleus, to which a prosthetic structure is adapted, is always fabricated. It can be customized in the event of implant inclination or implants in cervical contact, in which case customization of proximal areas is necessary. Universal posts are contraindicated in cases of insufficient interocclusal space and unsatisfactory tridimensional implant positioning. It can be fabricated in laboratory[3] for: Cases that require significant customization of prosthetic abutments, cases in which the soft tissue area subjected to rehabilitation has different papilla height or cases in which the gingival tissue height of the vestibular surface requires a screw-type post.

On the other hand, cases with limited interocclusal space, which do not require any type of alteration, may have customization performed in the patient's mouth. Should a component have to be angulated without the need for cervical preparation, a universal post can be used and directly installed inside the patient's mouth. This component is available in two different diameters (3.3 and 4.5 mm) as well as in two different options of coronary length (4 or 6 mm).

Choice will depend on the interocclusal space available and on the area of cementation. Angulated implants are available at 17° and 30°.

***Anatomical post***

It is a post similar to a screw-type universal post, but with a larger amount of metal for preparation. Exposed areas can be prepared in laboratory, similarly to screw-type universal posts, or by the dental surgeon himself. One type of anatomical post is used to replace central incisors, whereas the other type is for lateral incisors. The anatomical post is recommended for single prostheses cemented in esthetic zones. It is used in cases of buccal inclination of crown emergence profiles, given that it extends that cervical area so as to facilitate the emergence profile. It is advantageous for allowing adaptations in the coronary, cervical and inner contour portions.[9]

***0.2-mm customizable post***

In esthetic zones, Morse Taper implants must be installed infraosseous. However, this is not always possible and results in implant exposure in the oral cavity, thus hindering placement of intermediate components due to the apparent portion of metal, in which case a 0.2-mm customizable post is recommended. It is also used in cases of lack of gingival tissue to hide the cervical portion of intermediate components or implants badly positioned, which results in proclined screw-type emergence profiles. Furthermore, it is recommended for special cases of single cemented prosthesis with issues involving implant choice or placement.[9]

It has been developed to solve complications of complex cases. Ideally, this type of post should be avoided (the reason why it is not included in Neodent products catalog) in order to prevent the product's trivialization and loss of biological benefits provided by the Morse Taper philosophy.[3]

***Mini conical abutment***

Known as Morse Taper mini-abutment, MirusCone, Micruscone, Mini-abutment, Multi-unit, Micro-unit or UMA, it is an option for screw-retained multiple prostheses. It is offered in accordance with the aforementioned options of transgingival abutments and angulations. Mini conical abutment is contraindicated for single and/or cemented prostheses and in cases of insufficient interocclusal space as well as unsatisfactory tridimensional implant positioning.[9,18]

Straight mini conical abutment is recommended for multiple prosthesis implants, given that no anti-rotational component is included in the prosthetic cylinder, as the anti-rotational feature may hinder prosthesis cementation as a result of lack of parallelism between implants. A minimal interocclusal space of 4.4 mm must be achieved as from the mucosal level.[3,19]

As for implants inclined in the buccopalatal or mesiodistal direction in multiple prostheses, angulated mini conical abutment is recommended to achieve proper insertion axis for the prosthesis or to solve esthetic issues involving proclined implant emergence profiles. However, the type of load applied to inclined implants remains unchanged. This component is available at 17° and 30°. This type of angulation requires enough gingival tissue to hide the collar of angulated components and, thus, favor esthetics. In cases of mini conical abutment, the screw is connected to the intermediate component (fixed screw), whereas in cases of angulated mini-abutment the screw goes through it.[3]

Neodent developed an abutment for cases of reduced interocclusal space. It is known as CM micro abutment. It is recommended for screw-retained multiple prosthesis with a minimal interocclusal space of 3.5 mm as from the mucosal level, as well as for implants near each other.[19]

## Esthetic aspects related to tissues

The Morse Taper system is highly advantageous for esthetic zones, given that these situations normally require that the line between the intermediate prosthetic component and the implant be hidden. The Morse Taper system decreases the minimally required distance between implants as well as between teeth and implants, thus promoting maintenance of papillae, given that the correct distance between implants or between an implant and a natural tooth is essential to yield favorable esthetic results.[20]

According to Herman,[21] gingival esthetics around teeth is based on the invariable vertical dimension of healthy periodontal tissues, also known as biological distance. They are responsible for bone and gingival tissues protection and act as an important barrier between an organism's inner and outer environment. Such protection structures are also found around dental implants. Peri-implant tissues allow regeneration of the epithelium and connective tissue

with formation of gingival sulcus, junctional epithelium and connective tissue attachment fibers. In other words, the dimensions of biological distances between implants are similar to the biological distances around natural teeth.

Nevertheless, radiographic examinations of different implant systems reveal different peri-implant standards. Thus, the dimensions of biological distance seem to differ among implant systems due to the presence or absence of peri-implant resorption, as the biological distance depends on the location of the alveolar bone crest. The Morse Taper system preserves bone tissue, even after prosthetic abutment placement.[21]

A thorough evaluation of the type of gingival covering, soft tissue thickness (maintenance of gingival levels may not be ensured in cases of thin gingival biotype) and amount available are key to yield successful esthetic results. With regard to bone height and width, another factor plays an important role in determining the success by means of clinical and radiographic evaluations of hard and adjacent structures of implant sites:[22]

The absence of peri-implant inflammation and substantially reduced bone loss are largely responsible for maintaining esthetics in the long-term. Thus, Morse Taper connections represent the possibility of optimizing such problems, given that they are able to prevent bacterial biofilm accumulation and, as a consequence, gingival saucerization and inflammation.[6]

Interproximal papilla loss is directly associated with bone resorption around implants and intermediate components. Such loss may result from surgical trauma, overload, peri-implantitis, anatomical shape of the cervical region, implant surface features, biological adaptation, presence of microgap and the type of connection between the implant and the prosthesis, all of which can result in esthetic and speech issues as well as in potential food impaction.[23]

In cases of insufficient thickness of keratinized mucosa, peri-implant cosmetic surgery is recommended, which is essential for esthetics and proper oral hygiene. Should soft tissues partial loss be associated with high smile line, the case is extremely unfavorable and difficult, and requires reconstruction of the remaining soft and hard tissues.[24]

## Conclusion

The Morse Taper system has significantly more prosthetic advantages in comparison to hex implants, especially for anterior single teeth for which long-lasting gingival esthetics is extremely important. Additionally, the system presents more clinical, biological as well as biomechanical advantages. Therefore, it is reasonable to conclude that the Morse Taper platform is key to achieve high success rates and longevity of prostheses. Furthermore, it provides greater predictability in maintaining peri-implant conditions in anterior teeth rehabilitation.

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# Volcanoes or corals?!

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**Brånemark System MKIII TiUnite implant surface (Nobel Biocare) seen through scanning electron microscopy and atomic force microscopy (Piotto, M.A.B., 2011*).**

**How to cite this section:** Piotto MAB. Volcanos or corals?! Dental Press Implantol. 2013 July-Sept;7(3):30-1.

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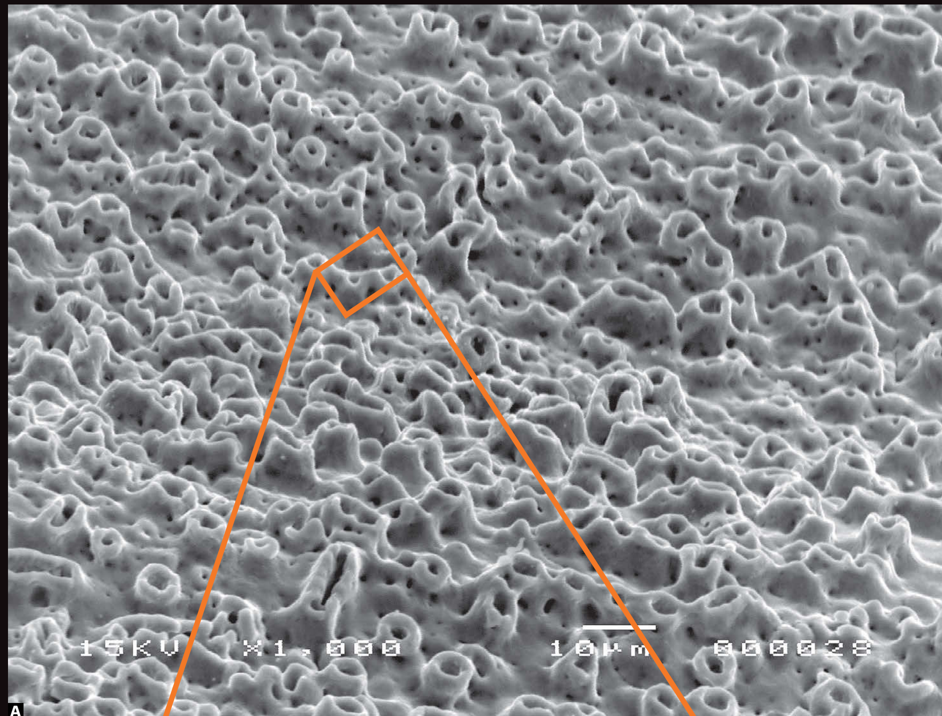
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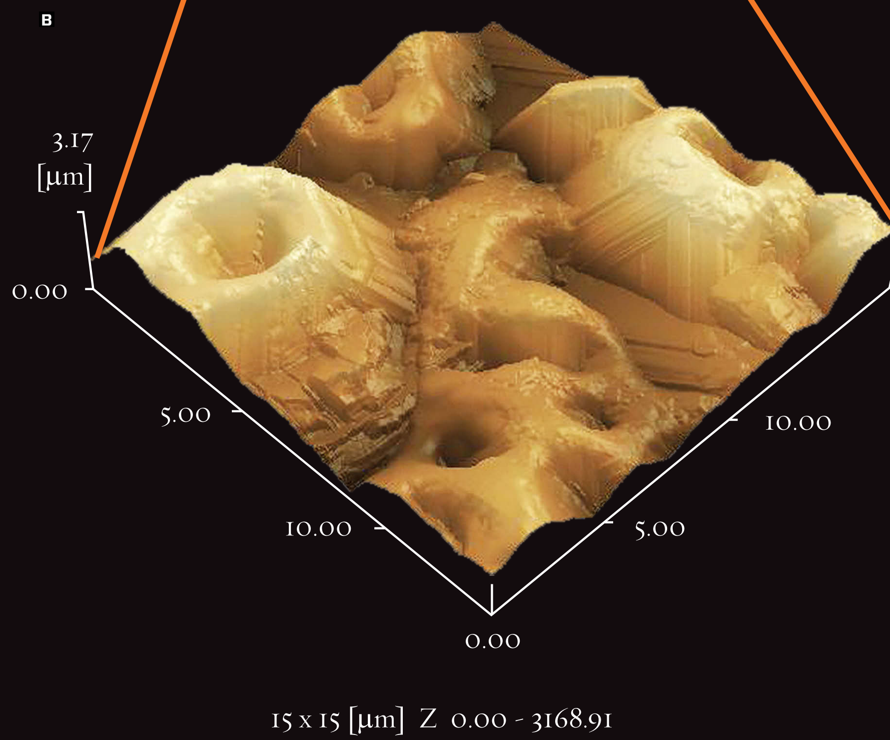
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# Subtleties of scientific communication: Precision, synonym, "Material and Methods" and "biomaterials"

Alberto **CONSOLARO***


## Abstract

The "Material and Methods" section has not been uniformly used by all journals and institutions. In addition to that, "Materials and Methods" or "Material and Method" have been mistakenly employed. The term "material", in its singular form, is a collective noun of intrinsic plurality. It also functions as a qualifying adjective for solid, liquid or gaseous substances that occupy space as an aggregate of particles that has mass.

"Methods" must be used in its plural form because no collective term is able to cover all procedures employed in a research, which often includes more than one single investigation method, for instance, reading, tests, calculations, trials and illustrations. The terms used for products known as "materials" or "biomaterials" are inappropriate for the meaning they convey in the Portuguese language. For this reason, they must be adapted. Or the language must change, which is perfectly possible given its dynamic nature! This article presents the basis for discussions on the theme.


**Keywords:** Material. Materials. Material and Methods. Methodology. Biocompatibility. Biomaterials.

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## Accurate terminology is very important for three reasons

Communication must be accurate. Every word has one or more than one specific meaning, and must be strictly chosen as an operator chooses a scalpel in surgery. Scientific communication must be even more accurate in order to avoid potential blanks or doubts. Word accuracy must be achieved for three reasons:

**1st** —The four branches of contemporary human heredity are: A) Genetics; B) Epigenetics: the study of changes in Genetics caused by environmental interference that does not result in mutation; C) patterns of behavior promoting social learning as a result of attitude, habit or reaction that induce others to acquire the characteristics of a group or family, and D) symbology: language symbols such as writing, speech and other icons shared by different generations and that are part of world heritage.

These four branches establish a dialogue between different generations, which implies that a codified world is left for future generations. Symbology is exclusively human. The more accurate and simple language symbols are, the more they will be understood in the future!

Changes in DNA as a result of body adaptation are slow, they occur every 100 years, approximately. Likewise, men cannot adapt and improve the storage capacity of their brains, which would alter the size of the organ and, as a result, hinder pregnancy and delivery.

Unable to make changes in the DNA or the size of the brain, men learned to pass on information to future generations by registering it as language symbols. To this end, they have developed high quality transgenerational information storage systems in the form of words and symbols.

**2nd** — Each word has its meaning and, at the same time, is a key or password that, whenever entered in a database, computer or device, will retrieve all information on a specific theme stored by current and previous generations. One wrong letter and the search will be changed, imperfect or incomplete.

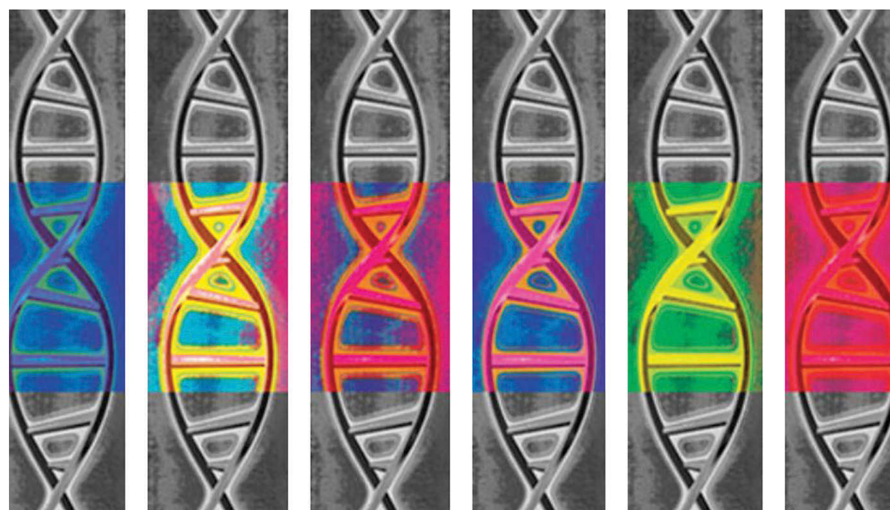

**Figure 1 -** Changes in DNA as a result of adaptation to the environment are slow. In order to provide information to future generations, men created new means of transmission or “the four branches of heredity”.

Using inappropriate words to retrieve stored information may find totally mistaken data.

The more accurate keywords are, the better databases — our current libraries — can be used. In other words, the more accurate a keyword is, the more complete and quick the search, the job, the device and the time spent will be.

3rd — Not long ago, using different words as reference to the same phenomenon or object was smart and erudite. However, this is currently seen as obsolete and inappropriate. In addition to hindering comprehension and accuracy, it broadens the number of key or passwords entered in databases to retrieve information previously or currently stored.

Retrieval of previously or currently stored information about a specific subject was also known as bibliographic research. It used to be carried out in a set of books known as index or reference work in which new publications were monthly or annually registered. An exhausting, but necessary job currently optimized by computers!

Analog or physical libraries used to have shelves full of outstanding reference works such as Current Contents, Index Medicus Literature, Index Dental Literature and Biological Abstracts, real databases that used to be manually used. The more reference works a library collected, the more information it stored in comparison to other libraries. In general, it would be the most important and the best library!

**Synonymy**, a collective term comprising different words for the same event, is still used in the first paragraphs of books about diseases, chemical substances or physical phenomena. Some diseases, substances and phenomena are known by 20 to 50 different terms. A web that hinders information retrieval, an intellectual and involuntary trap!

The scientific community should raise awareness about synonymy so as to decrease or eliminate it to the full extent of human knowledge: it is helpless and useless. Extensive synonymy is confusing, hinders comprehension and information retrieval. Exaggerated synonymy may be a sign of pseudo-erudition.

### “Material and methods” or “Materials and methods” or “Material and method”?

Terminological care must be taken when mentioning the different types of matter or “material” applied to the human body with different purposes, including material used to ease and speed up bone repair.

According to the dictionary, **“material”** means:

**Material:** *(adjective)* 1. Relating to or made of matter; 2. Physical rather than spiritual; 3. Rough, rude, dull; 4. Solid, heavy; 5. Practical, useful, objective; 6. Consisting of matter.

It also means:

**Material:** *(masculine noun)* 7. Something that is related to matter; 8. A set of objects, tools, machinery and parts that a finished work, construction, etc. may be based on or derived from; 9. Apparatus; 10. A substance from which something is made.

As for **“matter”,** the definition is as follows:

**Matter:** *(feminine substantive)* 1. Solid, liquid or gaseous substances that occupy space; 2. An aggregate of particles that has mass; 3. A material substance of a particular kind.

The academy hardly ever has time for subtle details such as perfectly appropriate terminology. For some philosophers, subtleness is home for the sacred and the evil,

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gods and devils: Thus, for good measure, let us be careful! This philosophical message is often seen as unpleasant, but it suggests that: the wrong or right points of a hypothesis or theory may be a minor detail embedded in an inappropriate name or term.

In the academy, one of the most frequently asked questions is: *Should the term "material" be used in its singular or plural form?*

"Material" may have two different connotations: an individual — functioning as a qualifying *adjective*; and a collective — a noun referring to a set of objects. A collective *noun*, even if in its singular form, refers to a group of creatures that belong to the same species.

As a collective noun, the term material stands for a set of things used for a particular purpose. A herd stands for a group of elephants that are kept together, while a bunch stands for a group of keys held together. Likewise, the products and objects used for a specific purpose in a research must be referred to by the collective noun *"material"*.

The use of "material" in its plural form is limited: When referring to more than one set of things; several herds or bunches. For this reason, it is generally accepted that the plural form of "material" as a noun is not used!

Chapters and headings that describe the scientific methodology employed in a research published in the form of an article are entitled "Material and Methods"

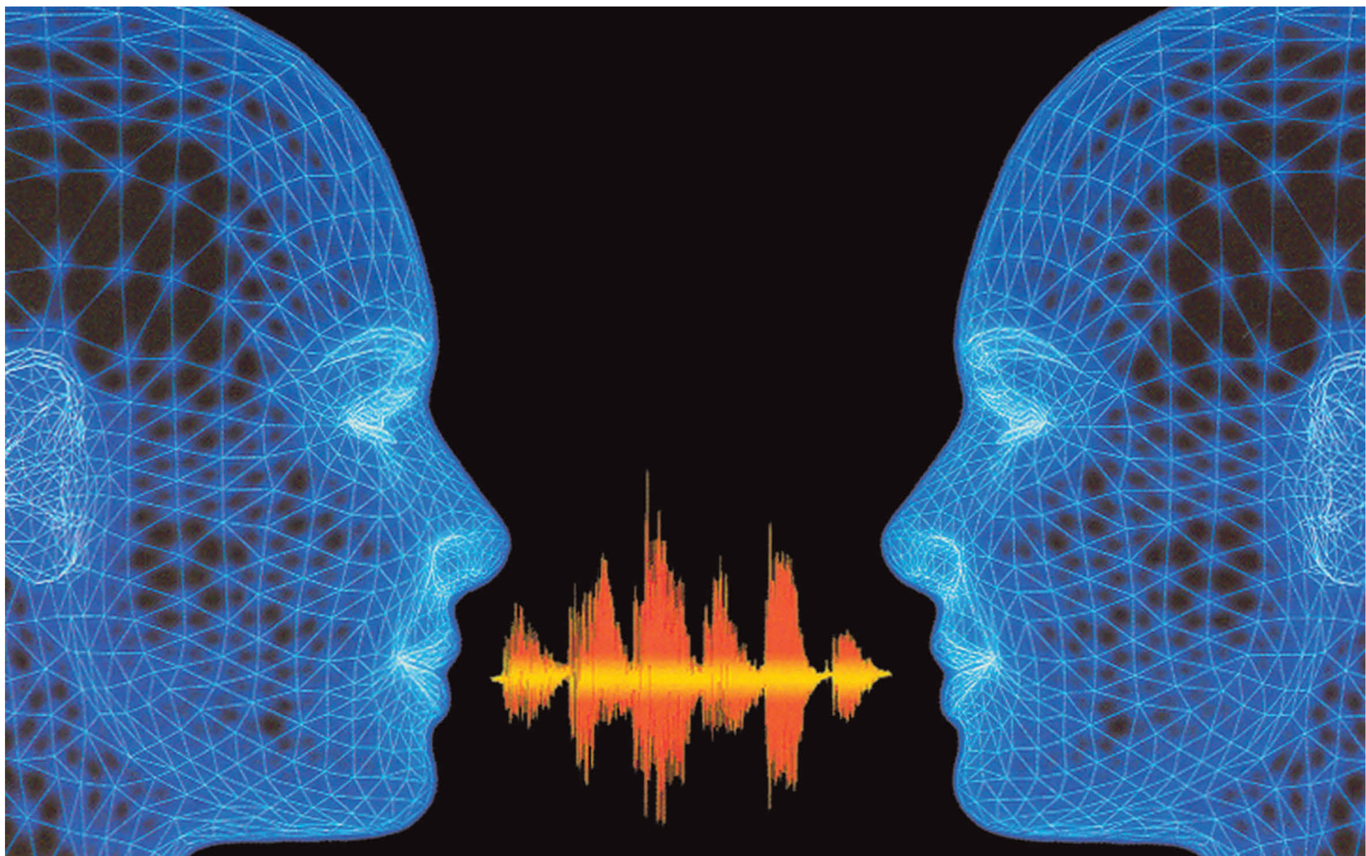

**Figure 2 -** Language symbols are one of the four branches of men's ability in transmitting something.

**Figure 3 -** In order to quickly register and pass information on, different languages have been created and employed in databases and libraries.

in case of studies conducted with several objects, tools, products and parts which, as a whole, must be referred to as "material" in its singular form. For instance: A shop sells building material. In other words, it sells a variety of products, tools and supplies for construction purposes.

In a dissertation or article, the chapter entitled "Material and Methods" refers to the whole set of objects and products used. Conversely, no collective noun is used in reference to a set of methods, often employed in association with more than one method. Researches are usually carried out by means of imaginologic, statistical, surgical, microscopic and photographic methods, which hinders the use of "Material and Method" in its singular form. The path that employs several methods to achieve a desirable result is known as methodology.

That is the reason behind the use of "Material and Methods", although the term "Materials and Methods" have been used and recommended by the guidelines of several institutions

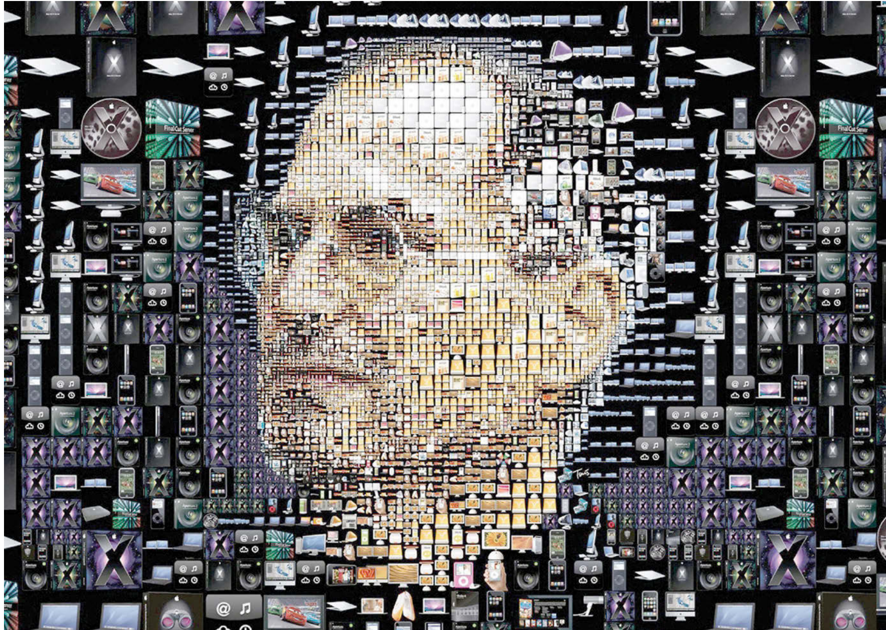

**Figure 4 -** Contemporary man uses symbology to be immortalized for future generations, as it is the case of Steve Jobs, co-founder of Apple.

and journals. Subtleness is generally related to refinement and absolute accuracy. Some studies, institutions and journals allow or recommend the use of "Patients and Methods" for considering that research subjects have a spirit or a soul and, for this reason, "Material and Methods" would be too impersonal for humans. Should that be the case, this chapter should have been entitled "Patients, material and methods", given that a set of objects, products and other tools are used to conduct the study. To be more precise, given that research subjects are not always ill, the term "People, material and methods" should be used instead. However, the term "Material and Methods" is generally used in modern sciences, even when the study sample comprises people.

## Using the term "biomaterial/biomaterials".

In our current society, we cannot change some basic concepts and violate our mother tongue by creating dialects with meanings that are restricted to a field of study — for instance, a specialty.

If “material” is a collective noun, how should we deal with the term “biomaterial/biomaterials”? When products aiming at improving bone repair are referred to as **“biomaterial”** by surgical suppliers, they make reference to an adjective that, according to the dictionary, stands for a product or object: Relating to matter; physical rather than spiritual; rough, rude, dull; solid or heavy; practical, useful, objective.

Although it may seem too different from what we are used to, the term **“matter”** should replace the term “material” used in the form of an adjective. As we have previously mentioned, “matter” stands for solid, liquid or gaseous substances that occupy space, an aggregate of particles that has mass or a material substance of a particular kind.

As for **“bio”**, functioning as an element of word formation, it comes from the Greek: indicating or involving life. For instance: biological, biography, etc.

As for **“life”**, it stands for the sequence of physical and mental experiences that make up the existence of animals and plants, which distinguishes them from dead organisms or raw matter. An organismic state characterized by capacity for metabolism, growth, reaction to stimuli, and reproduction. Life means existence. It also means an organismic state or condition that lasts from birth to death.

When the term “biomaterial” is used in Implantodontics, it probably makes reference to a matter-related product. When the term “material” is used as a collective noun, it functions as an adjective that qualifies something relating to matter. In this case, adding the term “bio” is meaningless, given that the product is no longer alive. Thus, it is suggested that the following be used instead: Bone repair matter or products with bioaffinity, or simply “matter” or “bioaffinity products” or further suggested terminology capable of identifying these products with greater accuracy.

**Bioaffinity** is a term widely used in Chemistry in reference to the property of a specific attraction between a biomolecule and other molecule, biological or not. As for **biocompatibility**, it does not compete with bioaffinity, given that it refers to the condition of being compatible with a living organism by not being injurious to adjacent tissues or harmful to the organism as a whole. Biocompatibility has a broad scope, given that it aims at maintaining an organism as a whole.

## Final Considerations: The correct is “Material and Methods”

The “Material and Methods” section of scientific papers, thesis and dissertations has not been uniformly used by all journals and institutions. Many doubts arise as a result of the inappropriate use of “Materials and Methods” and the recent improper correction “Material and Method”.

The term “material”, in its singular form, stands for a collective noun of intrinsic plurality. It represents a set of parts, apparatus, tools, objects and products used in research, and, for this reason, must always be used in its singular form.

Conversely, “methods” must be used in its plural form because no collective term is able to cover all procedures employed in a research, which often includes more than one single investigation method, for instance, reading, tests, calculations, trials and illustrations.

“Material” must not be used in reference to a product, given that its singular form functions as an adjective relating to matter: Solid, liquid or gaseous substances that occupy space as an aggregate of particles that has mass.

Widely used, the term “material” functions as a collective noun or a qualifying adjective employed to name or qualify something in its singular form.

Correcting such terminological distortions requires persistence. Perhaps the dynamic nature of language may embrace the meanings of terms that have been inappropriately used. Another feasible alternative would be to replace “material” by “matter” whenever the former stands for a singular concrete noun.

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# Behavior of peri-implant tissues in immediate implant with provisionalization: A literature review

Danielle Borges Nunes Fernandes **SILVA***
Leonardo da Costa **NEVES****
Enzo **QUERINO*****
José Carlos Martins da **ROSA******
Mauricio Andrade **BARRETO*******

**Abstract**

**Introduction:** Implantodontics has reached a level in which osseointegration alone is no longer enough for treatment success. Today, in addition to recovering function, the implant must be associated with esthetic restorations that are similar to natural dentition, in harmony with surrounding teeth and with other peri-implant structures. The healing process after tooth loss is unfavorable to soft tissues that follow bone remodeling, compromising esthetics. The use of immediate implants and provisionalization enables a treatment approach that aims at maintaining peri-implant tissues, replacing treatment of atrophy sequelae after extraction. **Objective:** The aim of this paper is to conduct a literature review in order to identify and discuss the determinants of morpho-esthetic-functional tissue peri-implant behavior in immediate implant placement with provisionalization. **Methods:** PubMed database was used as a research resource considering the period between 2003 and 2012. **Results:** Within the limits of this review, it was reasonable to conclude that the esthetic results in implant therapy are influenced by tissue biotype, especially in the peri-implant mucosa. The thin biotype revealed higher susceptibility to gingival recession. Conversely, tissue biotype revealed little influence over the height of the interproximal papilla. Filling the gap with autogenous bone graft contributed to the maintenance of the structures around the implant, but we can not affirm the existence of superiority between different graft materials. **Conclusion:** Subepithelial connective tissue graft seems to positively influence the level of marginal mucosa.

**Keywords:** Immediate dental implant loading. Tooth extraction. Single-tooth dental implants. Tooth alveolus.

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

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## Introduction

Clinical success of prosthetic rehabilitation with implant-supported prostheses in the anterior maxilla depends on prostheses esthetically satisfactory for both the patient and the dentist.[1] Today, with the high survival rates of implants, the goal has been to create an esthetic restoration that is similar to the natural tooth and stable over time.[2,3,4]

Implant placement in single edentulous patients is a highly described routine practice.[5] Several procedures for bone and gingival augmentation are often recommended[6,7] due to alveolar bone resorption that occurs during the first year after extraction and reaches its maximum rate during the first 6 months.[8] Unfortunately, even with technological development, these approaches imply failures in the preservation of residual bone level and marginal gingival contour. These changes lead to short, medium and long-term unsatisfactory esthetic results.[5]

Dentists' approaches towards recommending single-tooth extraction has been broadened. Implantologists who, a few years ago, commonly received patients with no teeth, "ready" to receive an implant, have increasingly been able to decide the best time for extraction and implant placement, which can influence treatment outcomes. Knowledge of alveolar bone physiology and healing processes has changed the planning protocols for cases of extraction in esthetic areas. Chen and Buser[9] didactically classified as Type 1, or immediate implants, implant placement at the time of extraction, as part of the same surgical procedure; as Type 2, or early implant, implants installed between four and eight weeks after extraction and after soft tissue healing with no clinically significant changes in bone; as Type 3, or early implant placement, implant placement between twelve and sixteen weeks after extraction, with major bone remodeling; as Type 4, or late implantation, implant placement six months after extraction, when the alveolus is completely healed.

Wöhrle[10] innovatively recommended immediate implant placement in fresh alveoli and with immediate loading. Later on, many authors described and improved his technique, proving it to be useful.[11,12,13] The technique of immediate implant and immediate loading seems to substantially contribute to the preservation of marginal architecture. Figures 1-6 show a case that illustrates the technique of immediate implants with provizionalization (Figs 1 to 6).

The presence of radicular fractures as well periodontal and/or endodontic complications is a challenging problem, since microbial and mechanical sequelae typically induce complete resorption of the labial bone plate. In these cases, the minimum requirements are hardly considered for implant placement and immediate loading. The techniques have been developed in order to associate alveolar bone augmentation procedures with immediate implant placement. However, the type of graft material as well as the surgical technique itself are far from reaching a degree of consensus, especially due to the large number of variables.

Kan et al[5] report that extrinsic and intrinsic factors can interfere in the results of immediate implant and immediate loading. Extrinsic factors related to the surgical technique include three-dimensional positioning and angulation of the implant,[14] placement time,[9,15] placement or not of graft[16,17] and the level of surgical trauma during extraction and implant placement.[13] As for the prosthesis, shape, provisionalization and manipulation are correlated.[18] With regard to implant design, macrogeometry, surface and implant/abutment interface are included.[19] Intrinsic factors are related to the patient, including gingival biotype,[5,12] periodontal disease, amount and quality of bone as well as oral health hygiene and maintenance.[20,21,22]

The aim of this paper is to conduct a literature review in order to identify and discuss the morpho-esthetic-functional behavior of peri-implant tissue after immediate implant placement with immediate provisionalization.

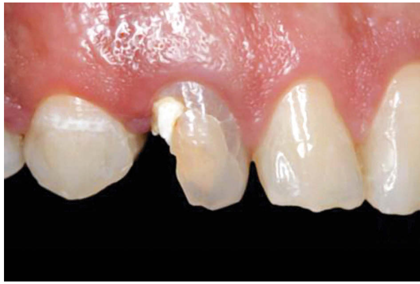


**Figure 1** - Clinical image of a right maxillary canine subject to extraction. Note the discrete loss of distal papilla height.

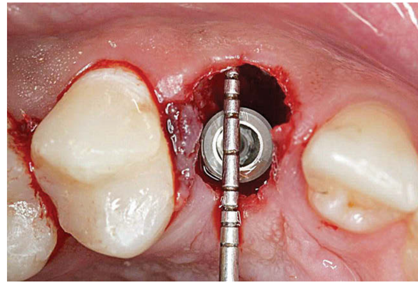


**Figure 2** - Note the use of a millimeter probe to measure the space between buccal bone plate and implant surface.

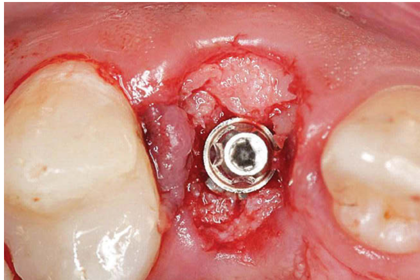


**Figure 3** - Note the gap filled with autogenous bone graft collected from the tuberosity.

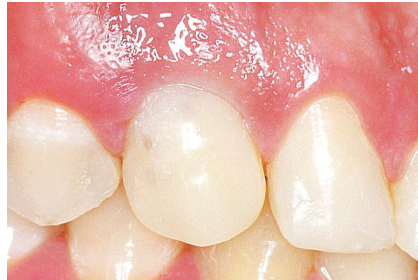
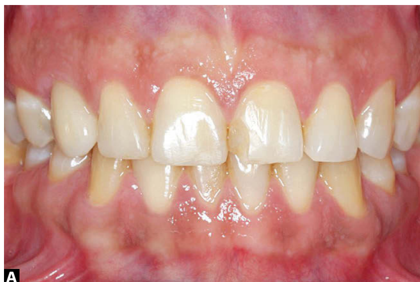
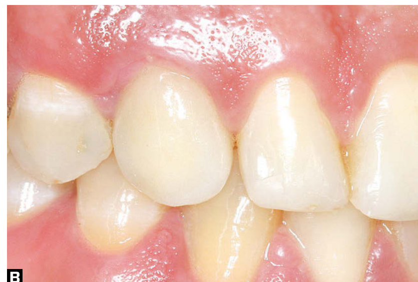


**Figure 4** - Postoperative with provisionalization four months after the procedure. Note the distal papilla totally filled and the maintenance of the gingival margin.





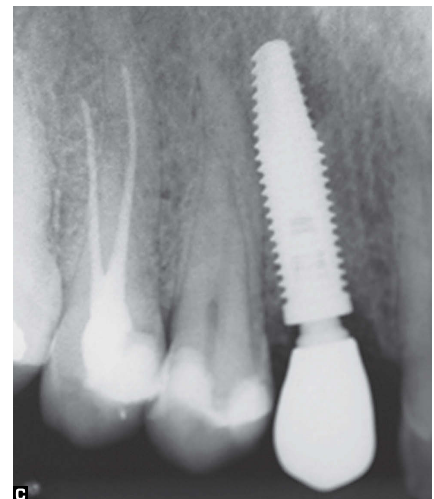


**Figure 5** - **A**) Final prosthesis. Note the esthetic peri-implantar tissue contour and its resemblance with the contralateral side. **B**) Final prosthesis. **C**) Final radiograph.

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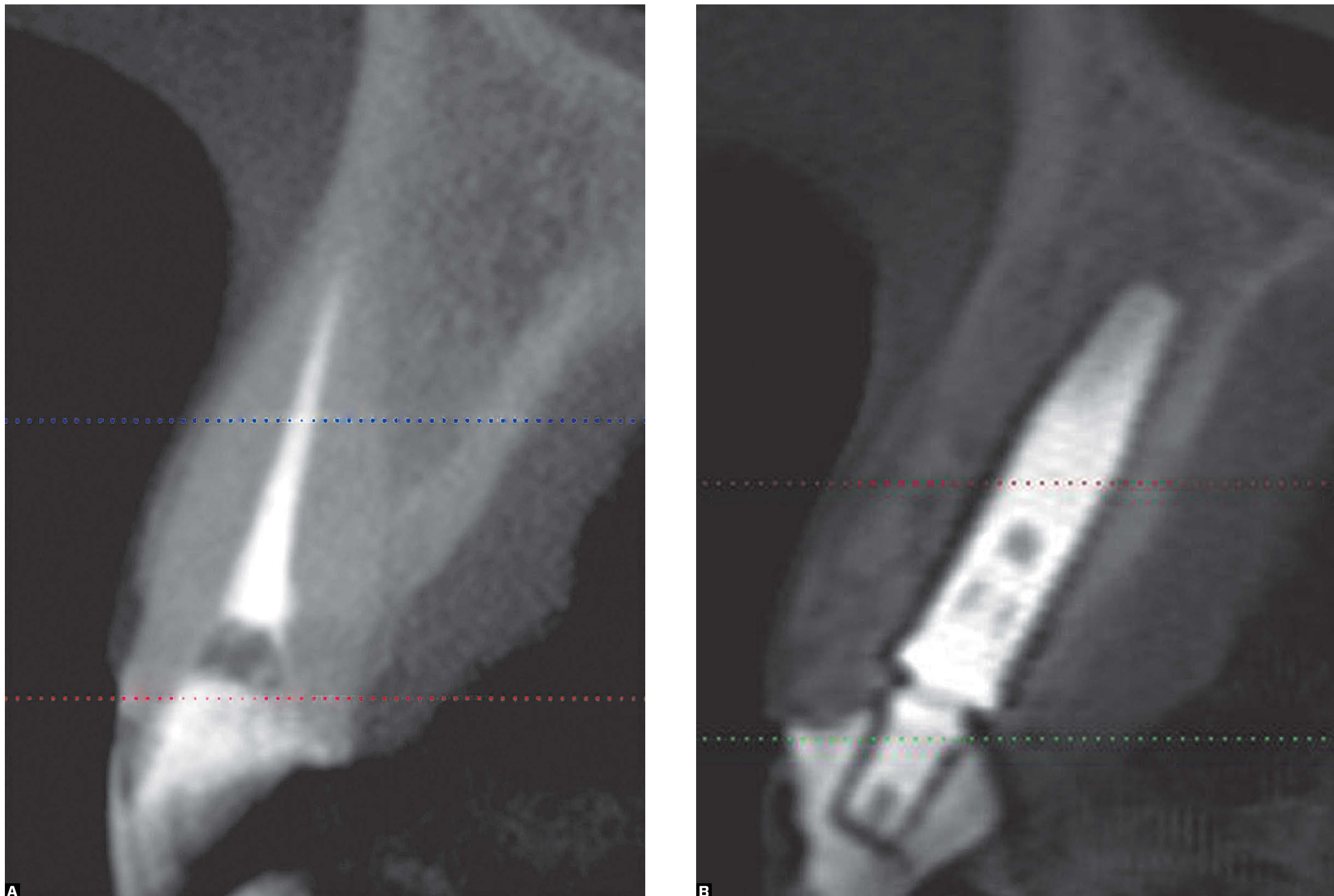


**Figure 6** - **A**) Initial tomographic image. **B**) CBCT one year after final crown. Note appropriate bone volume around the implant, particularly in the buccal cortical zone.

## Literature review

PubMed database was used as a research resource considering the period between 2003 and 2012 and the following keywords: provisionalization, bone graft and dental implant, immediate loading, tooth extraction, dental alveolus and single-tooth dental implants. Eighteen studies were selected and the result of this research is summarized in Table 1.

## Discussion

In the literature, it is understood that bone remodeling after extraction and peri-implant changes are esthetic complications of implant treatment performed in the anterior region, in addition to suffering multifactorial influence. With regard to the first bone-implant contact, Kan et al[5] and Raes et al[24] found losses in the mesial and distal crest in studies conducted with immediate implants

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without graft. Conversely, studies by Cooper et al[17] and Brown et al[19] revealed increased bone level without bone graft. Tsuda et al[16] also reported bone augmentation with xenogeneic (Bio-Oss®) and subepithelial connective tissue graft. However, Levin et al[28] used FDBA graft or biphasic calcium phosphate and found resorption of bone crest in the area corresponding to the first bone-implant contact, whereas De Rouck et al,[12] who also used Bio-Oss® graft, found mean mesial bone loss of 1.13 mm, and distal bone loss of 0.86 mm in three years. Intrinsic aspects of patients, study inclusion criteria, operators, graft material, lack of technical standardization and assessment methods may have yielded differences in the results.

Kan et al[5] found buccal recession (average of 1 mm) immediately after implant placement without graft, a result that was also found by De Rouck et al[12] who used Bio-Oss® graft. Tsuda et al[16] performed grafting with Bio-Oss® and connective tissue. In their study, gingival recession was obtained at a lower degree (0.05 mm), similarly to Cornelini et al[32] who used collagen membrane as graft material (recession of 0.5 mm). Without any graft material, Cooper et al[17] observed that the gingival margins were stable and increased in 83%; similarly to Brown et al,[19] who also noticed stability, with gains not greater than 0.2 mm. Conversely, Raes et al[24] found stability of the gingival margin in most cases, but with recession in only 7% of cases. They also reported that the results of flapless surgeries showed less recession than those found in conventional surgeries of the same study. Miyamoto et al[15] established a relationship between gingival recession and facial bone thickness greater than 2 mm; while Kan et al[5] observed that areas of thick gingival biotype showed significantly little changes in the buccal margins (0.56 mm resorption) in comparison to areas of thin gingival biotype in which resorption was as great as 1.5 mm.

With regard to the maintenance of papillae, Kan et al[5] and Cornelini et al[32] reported decreased papillae. El-Chaar et al[20] obtained a reduction of around 0.3 and 0.5 mm in papillae after one year of follow-up. In contrast, Tsuda et al[16] observed papillae filled with the Jemt's index[23] in 50% out of 80% of the sites assessed, relating the good results with the bone graft technique associated with connective tissue graft. Raes et al[24] found stability of papillae, corroborating the data obtained by Alberti et al.[39] On the other hand, the study by Brown et al[19] revealed an increase in the height of the papillae, with changes in the Jemt's index[23] of 2 (85%) and 3 (24%) in 8 weeks (65%) and one year (43%), respectively. It is worth noting that in the study by Raes et al,[24] the gingival biotype of the sample was thick, while in the study by Brown et al[19] the maximum gap was 1.5 mm, with intact alveoli walls. Alberti et al[39] reported that temporary adjustment favored papillae preservation.

Factors such as operators, methods for standardization of measures and selection of cases (gingival type, preservation of bone plate, bone thickness, implant-alveolus space, among other requirements) interfere in the results. In their study, Noelken et al[33] justify the maintenance of gingival architecture by a set of measures such as the palatal positioning of implants in relation to the residual alveolus, use of autogenous graft and bone reconstruction technique. According to the authors, these details contribute to yielding minimal inflammatory reactions, thus preventing significant bone resorption and collapse of soft tissues.

Huynh-Ba et al[34] report that, despite lack of general consensus, the minimum width of the labial bone plate required for bone maintenance would be around 2 mm. It is known that vestibular bone thickness interferes in the maintenance of vestibular bone crest vertical dimension. Also according to these authors, the use of graft would be justifiable due to compensation of the bone resorption expected, especially in the anterior region, which in most cases is not compatible with the bone volume recommended.

**Table 1** - Summary of some articles on immediate implant and provisionalization.

| Author/ year | Type of study | Follow-up time | Sample | Material and methods | Type of assessment |
|---|---|---|---|---|---|
| Kan et al[11] 2003 | Prospective | 1 year | 35 patients 35 implants | Immediate implant + provisionalization | Clinical and radiographic assessment pre, trans and postoperatively |
| Cornelini et al[32] 2005 | Series of cases | 1 year | 22 implants 22 patients | Temporary/immediate implant with flap + collagen membrane defects larger than 2 mm | Clinical assessment of probing insertion, buccal gingival margin position, papilla position. Radiographic assessment |
| Ferrara et al[29] 2006 | Series of cases | 4 years | 30 implants 30 patients | Temporary/immediate implant in intact alveoli + autograft filling the gap | Radiographic and photographic assessment; 10-point scale to assess patient's satisfaction |
| Cooper et al[7] 2010 | Prospective multicentric | 12 months | 139 patients 157 implants | Healed ridge X non-grafted fresh alveoli | Radiographs and photographs |
| Tsuda et al[16] 2011 | Series of cases | 1 year | 10 patients 10 implants | Xenogeneic graft in the space between alveolar wall and implant + connective tissue graft | Clinical and radiographic assessment |
| Kan et al[5] 2011 | Prospective | 2 to 8 years, mean of 4 years | 35 patients 35 implants | Implant + immediate provisionalization | Clinical and radiographic assessment pre, trans and postoperatively |
| Raes et al[24] 2011 | Clinical trial | 52 months | 39 patients 39 implants | Immediate implants (ITT) - 16 patients X Conventional implants (CIT) -23 patients without graft | Study models, photographs and radiographs |
| Galluci et al[26] 2011 | Prospective | 2 years | 20 patients 20 implants | Implant in healed ridge | Study models, photographs and radiographs |
| Brown et al[19] 2011 | Case report | 1 year | 27 patients 27 implants | Immediate implant with platform angled at 12º + Temporary implant without graft | Study models, photographs and radiographs |
| El-Chaar et al[20] 2011 | Retrospective | Mean of 23 months | 69 patients 162 implants | Immediate implant and immediate provisionalization without graft | Clinical and radiographic assessment |
| Becker et al[27] 2011 | Retrospective | 1 year | 100 implants 100 patients | Temporary/immediate implant without graft -Minimum Torque of 15 N - Minimum of 3 mm of bone around the apex of the implant | Clinical assessment |

| Results | Conclusions |
|---|---|
| · 0.55 ± 0.53 mm loss of buccal marginal gingiva<br>· 0.53 ± 0.39 mm loss of mesial papilla<br>· 0.39 ± 0.40 mm loss of distal papilla | Despite the changes in bone and gingival levels, patients were satisfied |
| · Radiograph showed bone loss of 0.5 mm after 12 months<br>· Gingival loss of 0.75 mm when compared to adjacent teeth<br>· Jemt's index score 2 (61%) and 3 (39%) | Immediate implant proved to be safe and predictable. The success rate and clinical/radiographic results were comparable to the standard protocol |
| · Success rate of implants: 93.93%<br>· No loss of bone or papillae<br>· Mean of esthetic score of 9.3 ± 0.65 after 4 years | The cosmetic results were satisfactory, without papilla or bone loss at 6 months and after 4 years |
| · Fresh alveoli gain of 1.3 mm in the first bone-implant contact<br>· Healed ridge, loss of 0.4 mm in the first bone-implant contact<br>· Buccal gingival margin remained stable, or there was gain of 83% in fresh alveoli and 87% in healed ridges | Fresh alveoli = best results with increased bone level of 1.30 mm X loss of 0.40 mm in healed ridge |
| · Radiograph showed gain of 0.1 mm in the first bone-implant contact<br>· Analysis of study models showed buccal gingival margin recession of 0.05 mm<br>· Jemt's papillary index: more than 50% of papillae filled | Ideal implant placement + bone grafts. Connective tissue graft favors esthetic results, minimizing risks of recession |
| · Thick biotype showed buccal margin recession of 0.56 mm, while thin biotype showed gingival recession of 1.5 mm | Thick tissue biotype showed greater stability of buccal margins<br>The effect of gingival biotype seems to be limited to the buccal gingiva, not influencing the levels of papilla and proximal bone crest |
| · After 1 year, the papillae were stable<br>· First bone-implant contact of 0.85 mm for ITT and 0.65 mm for CIT<br>· Only 7% of cases presented advanced buccal gingival recession in ITT, whereas there was significant recession of 1 mm in CIT | Flapless surgery (IIT) induced less gingival recession |
| Papillary height, buccal gingiva, width of keratinized mucosa and bone crest level were assessed. Papillae and buccal recession increased after final crown placement, with stability after 1 and 2 years | Papillae and buccal gingival margin recession increased. Stability after 1 and 2 years |
| · Gain of 0.78 mm in bone level at the first bone-implant contact<br>· Gain of 0.2 mm in the buccal gingival margins<br>· Increased papillae. Improvement of Jemt's index of 2 (85%) and 3 (24%) after 8 weeks for 2 (65%) and one year for 3 (43%) | Platform format favored esthetics. Gain in bone level and gingival margins, increased vestibular papillae |
| Success rate of 98.77% | Survival rates comparable to those reported with late-loading implants |
| · Success rate according to Albrektsson's criteria: 99%<br>· Minimal gingival recession | Immediate implants with provisionalization can be effective, but at least 3 mm of residual alveolar bone must be observed around the apex of the implant. Primary stability should be assessed, although there is no consensus regarding the minimum required torque |

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| Author/ year | Type of study | Follow-up time | Sample | Material and methods | Type of assessment |
|---|---|---|---|---|---|
| Cosyn et al[37] 2011 | Prospective | 3 years | 25 patients 25 implants | Temporary/immediate implant minimum flap + xenogeneic graft filling the gap | · Esthetic assessment with PES and WES indexes<br>· Radiographic standardization through occlusal feedback |
| Levin et al[28] 2011 | Retrospective | 3 to 18 months | 23 patients 30 implants | Allograft + collagen membrane | Radiographic assessment at implant placement and 12 weeks after the final prosthesis |
| Raes et al[35] 2012 | Prospective | 52 months | 48 patients 48 implants | Fresh alveoli without graft (IIT) X healed ridges without graft (CIT) X implants 4 months after graft with bovine biomaterial (GIT) | · Radiographic assessment (paralleling technique with device to standardize the position)<br>· Assessment of patient's satisfaction through questionnaires (OHIP)<br>· Assessment of pink esthetics through PES, and white esthetics through WES |
| Malchiodi et al[36] 2012 | Prospective | 3 years | 58 patients 58 implants | Filling the gap with autogenous bone collected through milling | Clinical and radiographic assessment in 3 stages: (surgery, six months and 2 years later) |
| Spinato et al[40] 2012 | Retrospective | 32 months | 41 patients 45 implants | Filling the space between implant and alveolar wall when greater than 2 mm with autogenous bone or bone substitutes (xenogeneic, allogeneic), or associations | Clinical and radiographic assessment in 3 stages: At implant placement, 6 months later and at the last visit |
| McAllister et al[38] 2012 | Prospective | 24 months | 55 patients 60 implants | · Use of thread design implant (Nobel) that favors increased primary stability<br>· Minimum insertion torque of 35 N | Clinical and radiographic assessment at $T_0$, 3 months, 6 months, 12 months and 24 months |
| Alberti et al[39] 2012 | Prospective | 1 year | 70 patients 70 implants | · 25 implants with provisionalization in fresh alveoli X 45 single implants in healed ridges<br>· In cases of fresh alveoli, surgery was flapless. In healed ridges, surgery was with buccal mucoperiosteal flap<br>· Minimum torque of 40 N<br>· Gaps larger than 2 mm were filled with particulate bone<br>· Temporary implants were made within a distance not greater than 5 mm between proximal bone crest and the contact point<br>· After 8 weeks, adjustments were made in the crowns so as to favor esthetics of buccal margin gingiva | · Clinical and radiographic assessment of patient's satisfaction through questionnaires<br>· Use of a device to standardize the positioning of radiographs<br>· Radiographic assessment at: $T_0$ (8 weeks) 6 months and 1 year |

| Results | Conclusions |
|---|---|
| · Mesial bone loss of 1.13 mm and distal of 0.86 mm in 3 years<br>· Tendency towards papilla regrowth between 1 and 3 years<br>· Mesial papilla recession of 0.05 mm, distal of 0.08 mm and buccal recession of 0.34 mm<br>· Only 8% of cases showed buccal recession greater than or equal to 1 mm | A careful selection of cases excluding thin tissue biotype and buccal bone defect is essential to yield good results. A tendency towards papilla regrowth was identified along 3 years, thus demonstrating that they are not completely reshaped after one year |
| · Implant survival rate of 100%<br>· Bone maintenance of 83% | Bone maintenance of 83% |
| · After 1 year, stability of buccal marginal gingiva in IIT and CIT, recession of 1 mm in GIT<br>· After 52 months, buccal recession in 7% of IIT cases, 43% of CIT cases, and 22% of GIT cases | It is important to carefully select the method of treatment. The quality of life of patients who receive immediate implants in esthetic areas changes significantly |
| · There was no significant crest remodeling within 3 years, but there was buccal recession<br>· Gingival marginal level ranged between 0.5 and 0.6 mm, 40.6% showed no discrepancy while 12.5% showed variation greater than or equal to 1.5 mm | Increased distance between proximal bone crest and the contact point may impair soft tissue esthetics.<br>Maintenance of hard and soft tissues around the implant are the key to obtaining satisfactory final results, for which correct implant positioning is necessary |
| · There was no difference between groups with regard to implant stability, bone level and soft tissue level<br>· Bone loss of 0.65 mm in 6 months, and 0.94 mm at $T_2$ in both groups<br>· Presence of papillae in 93% of cases at $T_1$, in both groups, and 95% at $T_2$ | Provided that tissue biotype is thick, there are no significant differences between the materials used for filling the implant-alveolus space |
| · Survival rate of 98.3%<br>· Marginal bone loss of 0.22 mm ± 1.3 mm in 1 year<br>· Bone gain of 0.12 mm ± 0.77 between 12-24 months<br>· Papillary increase after 2 years | The result obtained after 2 years demonstrates that immediate implant is safe and that other factors such as sufficient bone volume and minimum insertion torque of 35 N should be considered. Implant design favors primary stability. |
| · Survival rate of 100%<br>· All papillae were preserved<br>· No evidence of gingival recession<br>· Patients reported high satisfaction | Inclusion criteria such as the use of long implants, treated surface, primary stability and implant positioning influence treatment outcomes. Adjustments to the temporary implant seem to favor papilla preservation |

## Conclusions

1. There is no consensus among authors about the surgical technique, the graft materials, the type of implant and prosthetic procedure regarding immediate implant placement and provisionalization. However, the immediate implant technique seems to yield satisfactory clinical and esthetic results;
2. Tissue biotype influences the esthetics of implant therapy, especially the peri-implant mucosa. Thin biotype had greater susceptibility to recession;
3. Tissue biotype showed little influence over the height of the interproximal papilla;
4. Filling the gap with autogenous bone graft contributed to maintaining the structures around the implant. However, we can not affirm that some graft materials are superior to others;.
5. Subepithelial connective tissue graft positively influences the level of buccal marginal mucosa;
6. Further long-term controlled clinical trials are needed to determine the real influences of intrinsic and extrinsic factors over the morpho-esthetic-functional behavior of peri-implant tissue in immediate implant placement with provisionalization.

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# Lower protocol in patient submitted to radiotherapy: Case report

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## Abstract

**Introduction:** Combining surgery and radiotherapy is common to treat malignant tumors of the head and neck. Such procedure establishes tissue alterations that result in fragile mucosa, xerostomia, improper anatomical shape and myodynamic disorders, which hinders patient's oral function and rehabilitation. Placement of implant-supported prosthesis proves useful for rehabilitation of those patients. **Objective:** The present study reports a case of a patient subjected to high doses of radiotherapy after surgical removal of a malignant tumor located on the floor of the mouth. **Methods:** Six implants were installed in the anterior region of the mandible and a prosthesis was fabricated according to Brånemark's protocol. **Conclusion:** It is reasonable to conclude that osseointegrated implants can be safely employed, provided that special care be taken with regard to the adverse effects produced by resection and radiotherapy. Improvements in mastication, speech and esthetics promote patient's social reintegration, thus minimizing discomfort and suffering, in addition to optimizing therapeutic results and quality of life.

**Keywords:** Dental implants. Osseointegration. Radiotherapy.

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

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## Introduction

The use of osseointegrated implants placed in non-irradiated patients has been widely reported, however, little is known about implants placed in irradiated bone. Malignant neoplasms of head and neck are the seventh area most affected by cancer. Five-year survival rates for patients with oral cancer are of 59%, whereas for patients under treatment for salivary gland cancer it reaches 69%. Tumor stage at diagnosis as well as advanced age negatively influence prognosis. Proper functional rehabilitation proves necessary, given that a significant number of patients survive more than five years after diagnosis.[1,2]

Oral and maxillofacial tumors of head and neck may be treated by surgery, radiotherapy or a combination of both. Chemotherapy is also often used. All aforementioned treatment methods can produce adverse effects on soft and hard tissues of the oral cavity.[3] Surgical treatment for malignant neoplasm of oral mucosa followed by radiotherapy often result in unfavorable anatomical and physiological shape, which hinders prosthetic rehabilitation.[4] Additionally, these treatment methods may significantly affect function and esthetics, resulting in facial deformity, soft and hard tissue loss as well as speech, deglutition and mastication impairment. In these cases, conventional dental rehabilitation are less successful due to distortions between intraoral anatomical shape and the adverse effects caused by radiotherapy.[5] Thus, restoring function after oncological surgery in the oral cavity is one of the main challenges faced by oral and maxillofacial surgery.

In the past, implant rehabilitation was not recommended for irradiated patients. However, improvements in surgical techniques and the development of specific clinical protocols have enabled more predictable clinical outcomes. Prosthesis-based implant rehabilitation can significantly improve patient's quality of life after cancer treatment, thus promoting mastication, speech and deglutition, recovering soft and hard tissues support, improving patient's self-esteem and social coexistence.[6]

The adverse effects produced by radiotherapy on head and neck have been well reported in the literature. In these conditions, several changes may decrease the potential of cure of soft and hard tissues for implant therapy. Radiotherapy results in progressive fibrosis of blood vessels and soft tissues, xerostomia and decreased bone healing.[3] The prevalence and intensity of oral conditions caused as a result of radiotherapy depend on radiation dose and field as well as on patient's individual response. Complications occur approximately in 90% of patients carriers of malignant neoplasms of head and neck.[7] As for bone tissue, radiotherapy promotes reduction in the activity of osteoblasts and changes in blood vessels, which results in decreased bone irrigation and, as a consequence, higher vulnerability to infection and decreased healing capacity. Recent studies carried out with humans demonstrate that the risk of implant placement in irradiated bone was from two to three times higher in comparison to non-irradiated bone.[8] However, studies conducted with animals and human beings subjected to radiotherapy revealed that a radiation dose of 50 Gy assured long-term implant survival. Patients treated with radiation doses lower than 50 Gy run the same risk of implant loss as non-irradiated patients do.[9]

The literature reports irradiated mandible as the site of choice for implant placement, given that it ensures high survival rates. Many studies report high failure rates for implants placed in irradiated maxilla.[2] The majority of researches reports twice as much failure in the maxilla in comparison to the mandible.[8]

Time interval between the last radiation appointment and implant placement is also key to successful osseointegration. An ideal time interval has not been established yet. However, it is common sense that a time interval of 6 months or less, after the last radiation appointment, is more harmful due to carrying high risks of surgical complications. An interval between 6 and 24 months is considered less harmful. On the other hand, implant placement

many years after radiotherapy (over two years) is considered unfavorable, given that the effects produced by radiotherapy are progressive and cumulative.[8]

## Case report

A 56-year-old male patient sought the Residency in Oral and Maxillofacial Surgery and Traumatology at the State University of Western Paraná (UNIOESTE) for oral rehabilitation through osseointegrated dental implants. The patient reported being hypertensive and having undergone treatment for oral cancer five years before. Patient's pathological analysis revealed keratinizing epidermoid carcinoma (stage pT2-N1-Mx) on the floor of the mouth, with metastasis in cervical lymph nodes. After diagnosis, he underwent surgery for tumor extraction and was subjected to 60-Gy-dose radiotherapy. Patient had become fully edentulous after treatment onset, since when he never used any type of dental prosthesis. He presented significant loss of vertical dimension and absence of lip support with collapse of perioral soft tissues, which gave him an older appearance (Fig 1). Treatment also resulted in anatomical defect of soft tissue because, after tumor extraction, the floor of the mouth was replaced by the tongue. Patient presented dry, fibrous mucosa,

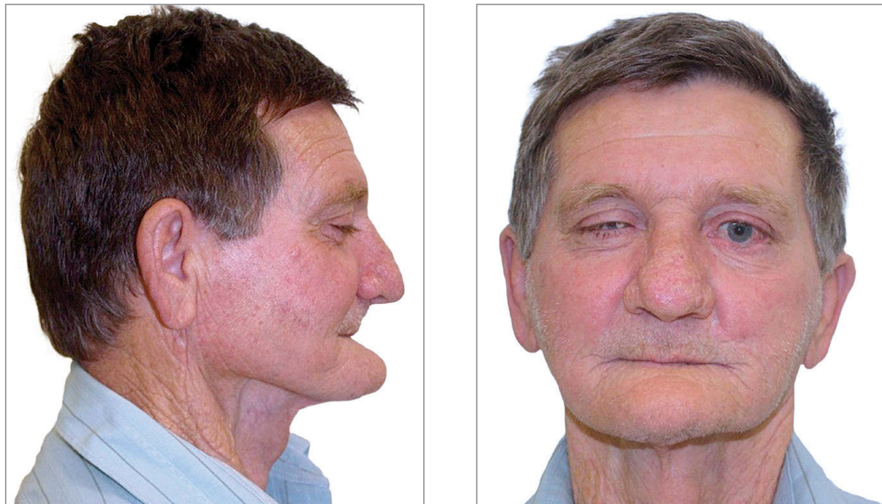


**Figure 1** - Lateral and frontal view of patient's facial aspect.

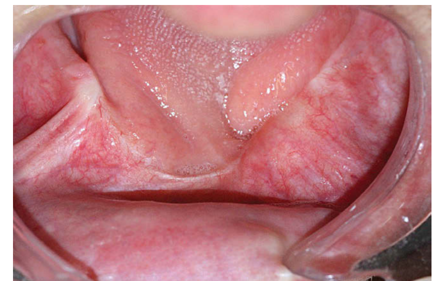


**Figure 2** - Initial intraoral aspect.

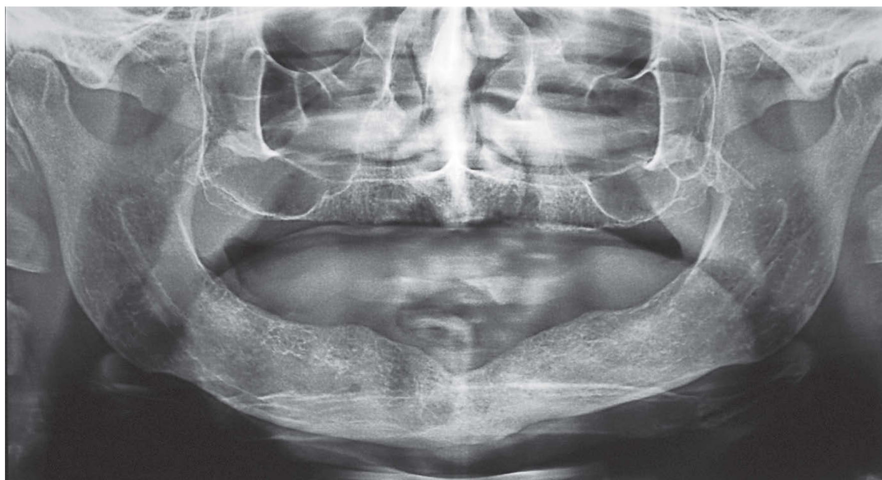


**Figure 3** - Initial panoramic radiograph.

xerostomia, absence of attached gingiva, buccal and lingual fold, as well as cicatricial adhesions (Fig 2). He also had considerable difficulty in speech, mastication and deglutition as a result of the tongue being sutured to the floor of the mouth, a totally unfavorable condition for conventional prosthesis. Radiographic examination revealed healthy bone tissue without osteoradionecrosis, but with bone defect in the anterior region of the mandible (Fig 3).

Initially, three surgical procedures were carried out under local anesthesia so as to release patient's tongue (Fig 4). Subsequently, six cone-shaped implants, 4 mm in diameter and 10 mm (three implants), 11.5 mm (two implants) and 13 mm (one implant) in height were installed. Patient's amount of bone allowed four implants to be placed in the intermental foramen region, whereas two were placed posteriorly to the foramen. Implants underwent surface treatment by a physical-chemical process of subtraction through abrasive blasting and treatment. The pre-operative phase comprised antibiotic prophylaxis with amoxicillin (1 g) one hour before the procedure. During the post-operative phase, the patient remained under antibiotic therapy (amoxicillin — 500 mg every eight hours, during seven days), in addition to anti-inflammatory (nimesulide — 100 mg every 12 hours, during three days) and analgesic medication (dipyrone — 500 mg every six hours, during three days). Suture was placed with a 4.0-mononylon thread. Suture dehiscence and, as a consequence, bone exposure were observed after a one-week post-operative phase. For this reason, debridement and a new suture were carried out. Dehiscence remained in the following weeks, even though it progressively reduced. In the following weeks, de-epithelization of edges was carried out with scalpel blade 15 so as to induce healing by secondary intention. After 45 days, healing was satisfactory, with the covering screws of three implant exposed. During this period, mouth washes with 0.12% chlorhexidine were performed every 12 hours. The patient was advised about oral hygiene and monitored on a monthly basis (Fig 5).

Nine months after implant placement, the patient underwent a procedure for implant reopening. Patient's radiographic exams revealed healthy mucosa with osseointegrated implants without any signs of osteoradionecrosis (Figs 6, 7). Procedures for implant reopening as well as placement of intermediate abutment and cover cap were carried out (Fig 8). After 30 days, implant impression was performed and lower-protocol as well as antagonist-arch prostheses were fabricated.

## Discussion

Dental implants are essential for rehabilitation of oral cancer patients after surgical resection. Radiotherapy was

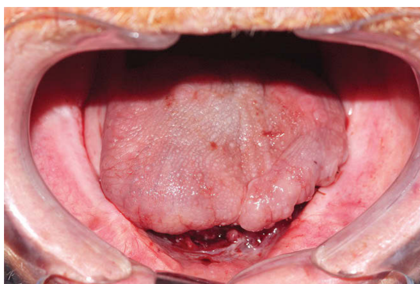


**Figure 4** - Surgery immediate post-operative phase to release the tongue.

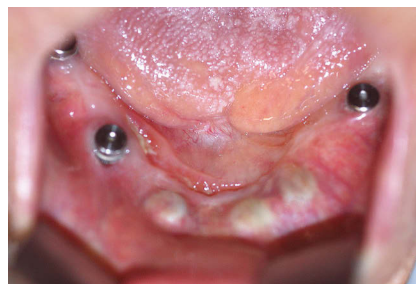


**Figure 5** - 45-day post-operative phase after implant placement.

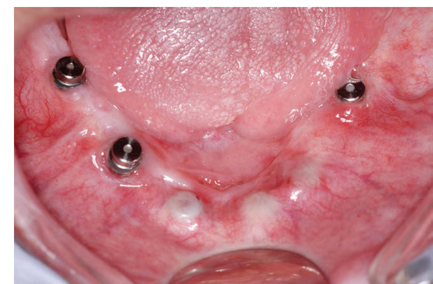


**Figure 6** - Intraoral aspect nine months after implant placement.

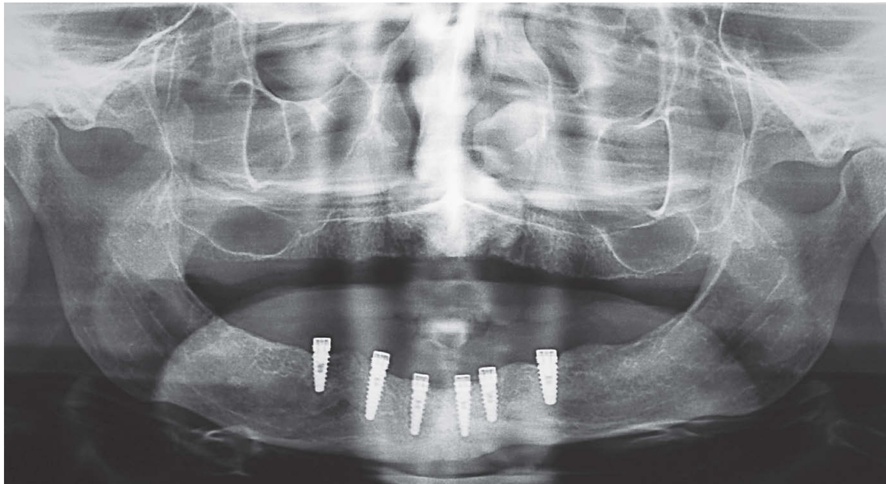


**Figure 7** - Panoramic radiograph nine months after implant placement.

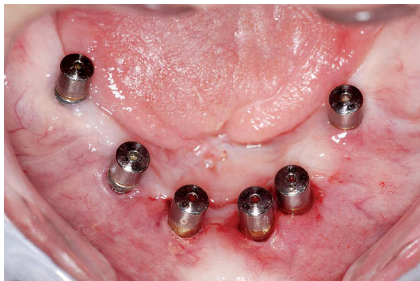


**Figure 8** - Intermediate abutment and covering screws placed immediately after reopening.

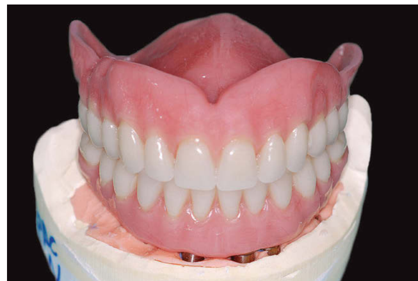
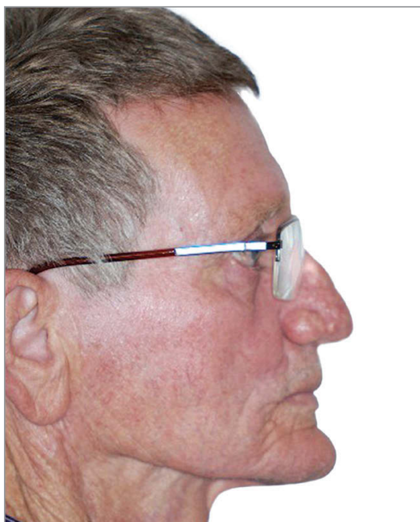


**Figure 9** - Finished lower protocol and complete upper prosthesis.



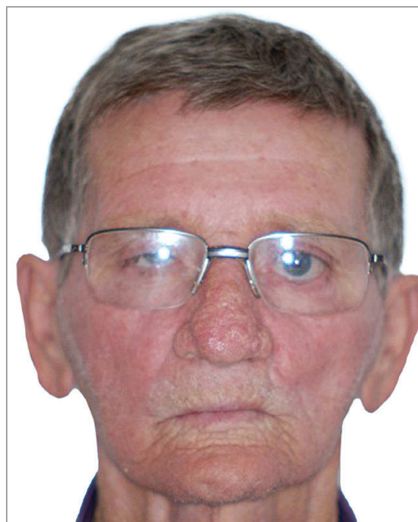


**Figure 10** - Lateral and frontal view of patient's facial aspect after prosthesis placement.

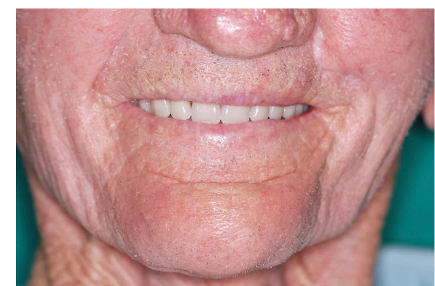


**Figure 11** - Patient's smile after prosthesis placement.

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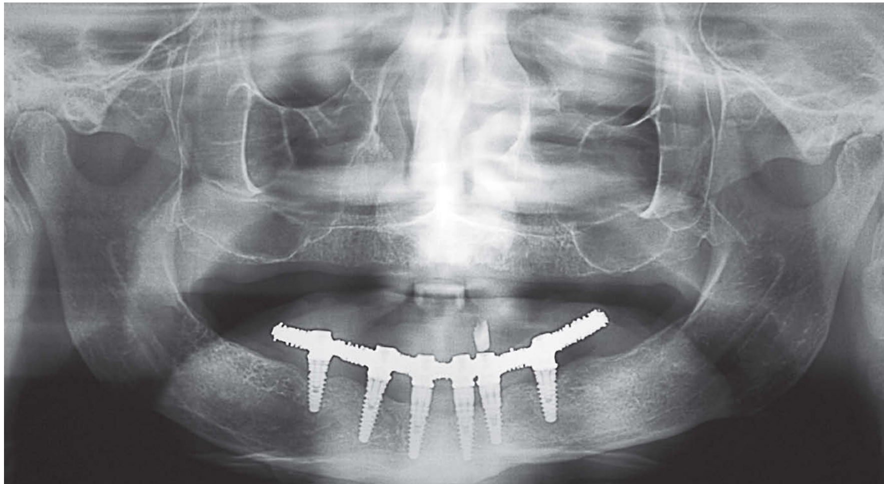

**Figure 12** - Panoramic radiograph after rehabilitation.

originally a contraindication in cases of implant placement. However, the need to optimize the rehabilitation of patients with cancer has refuted such position. Precisely predicting the issues that risk osseointegration is key to successfully perform the treatment of irradiated patients.[10]

Orofacial alterations in patient's anatomical shape as a result of tumor resection, surgery, proprioceptive insensitivity, changes in buccal lip space and mobility of the tongue, in addition to irregular bone contour, hinder placement of conventional removable prosthesis in most patients. Additionally, should radiotherapy also be employed in these cases, patients will develop atrophic mucosa and xerostomia, which further hampers the use of removable prostheses as a result of local irritation, ulceration and bone exposure. Osseointegrated implants have contributed to solve the aforementioned issues, given that they allow proper tooth-bone rehabilitation by means of implant-supported and implant-retained stable prostheses.[5]

Radiotherapy aims at aiding or eradicating a tumor by exposing it to high doses of ionizing irradiation. Ideally, irradiation is well endured by surrounding structures. In practice, radiotherapy may result in some degree of damage, whether transient or permanent, caused to tissues. Oral complications of head and neck radiotherapy include xerostomia, loss of taste, alterations in the oral microflora and salivary composition, mucositis, glossitis, increased carious activity, salivary gland dysfunction, dysphagia, muscular fibrosis, temporomandibular joint dysfunction, mucosal dysfunction and bone necrosis.[10,11]

This research focused on rehabilitation with osseointegrated implants and implant-supported prostheses due to patient's unfavorable anatomical shape with thin and friable mucosa presenting xerostomia. Additionally, the patient presented bone height and thickness that favored implant placement also in post foramen regions. Implant-supported prosthesis is recommended to avoid contact with the mandibular mucosa. Implant-retained or implant-mucosa-supported prostheses allow movements that traumatize the fragile mucosa which, due to difficulties in adaptation, may result in bone exposure and, as a consequence,

osteoradionecrosis. Osteoradionecrosis is a morbid, chronic condition that results from the effects of radiation on tissues. Those effects lead to decreased blood supply to the mucosa and subjacent bone, causing hypervascularization, hypoxia and, as a result, major bone exposures, devitalization and pathologic fractures. Furthermore, the most adverse effect of radiotherapy is the development and persistence of xerostomia, which results in increased viscosity and decreased production of saliva, thus considerably removing or reducing salivary biofilm — a prerequisite for retention and comfort during the use of total and removable partial prostheses. Endothelial changes that result from decreased blood flow to soft and hard oral tissues influence the use of conventional mucosa-supported prostheses, causing it to be less safe and comfortable.[5,12]

The incidence of osteoradionecrosis after radiotherapy for oral cancer has decreased in the last decades from 11.8% (in 1960) to 5.4% (in 1970 and 1980), reaching 3% after 1997. It is believed that such reduction is the result of improvements in patients' oral health before treatment, in addition to the use of more directly applied radiation, in which only smaller portions of the mandible receive high-dose radiation.[13]

The traditional theory about the effects of radiation suggests that it causes endarteritis which leads to tissue hypoxia, hypocellularity and hypovascularity which, in turn, may lead to tissue degradation as well as chronic wounds that do not heal. Moreover, radiotherapy reduces the proliferation of bone marrow cells, collagen as well as cells from the endothelium and periosteum. New models suggest that damage caused to osteoclasts occur before vascular alterations and that, as a consequence, decreased bone remodeling is the essential core of tissue damage. The extension of change depends on the dose, field and type of radiation.[9] Thus, a radiation dose of 50 to 65 Gy is not the limit for implant treatment. The literature asserts that a radiation dose higher than 60 Gy is the main cause of failure. For this reason, doses higher than 50 Gy are considered less favorable for implant placement.[6] The absence of failure in implant placement with radiation doses lower than 45 Gy may be due to the low incidence of such low doses.[14]

Common procedures also include antibiotic prophylaxis carried out in patients subjected to surgical treatment in irradiated areas. In addition to being non-evidence based, the use of antibiotic prophylaxis to minimize the risk of osteoradionecrosis is not clinically supported.[4] Nevertheless, prophylaxis is recommended for implant placement due to the high risks of infection for this type of surgery (from 10 to 15%), as stated by the American College of Surgeons.[3]

Implant placement and reopening performed at the right moment are key to successful osseointegration in irradiated areas.[15] The time interval between radiotherapy and implant placement surgery may affect osseointegration.

Radiation applied a few decades ago seemed to have a more negative effect on implant survival than radiotherapy employed nowadays. That may be due to low-energy radiotherapy applied in the past, given that, today, the forms of energy are higher and fragmented. Another explanation includes progressive endarteritis in the irradiated bone, which tends to increase as time goes by.[10]

Most cases of bone damage seem to occur before the sixth month of radiotherapy. Implants placed within a short period of time (before six months) after radiotherapy may not undergo osseointegration. Partial recovery of microvascularization occurs between the third and sixth month, whereas recovery of bone healing capacity occurs 12 months after radiotherapy. Many researchers recommend a waiting period of 12 months after radiotherapy

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before the onset of implant rehabilitation. A period of six to 18 months after radiotherapy offers low risks, however, such risks tend to increase over time. For this reason, a waiting period of 12 to 18 months is recommended between radiotherapy and implant placement.[2,6,10]

In addition to that, presurgical clinical and radiographic examinations should be taken not only to analyze the health of soft tissues, salivary flow and radiological appearance of bone, but also to perform digital palpation. Patients with soft tissue ulcer, exposed necrotic bone or history of healing issues should not undergo dental implant therapy due to their probability of complications.[16]

The surgical protocol includes careful and minimally invasive procedures for tissues: a small incision in the center of the crest with as little detached periosteum as possible — which is essential to maintain its blood supply —; bone drilling with low heat production; placement of long, wide-diameter implants; perfect adaptation and closing of wound edges; antibiotic therapy; use of provisional prostheses to avoid tissue trauma; careful oral hygiene.[16] During each step of perforation, receptor sites must be carefully assessed so as to identify evident bleeding in healthy bone tissue.[18]

In the case reported herein, the patient had a thin mucosa in spite of the waiting time after high-dose radiotherapy. Nevertheless, he proved to be healthy, without history of complications associated with radiotherapy, except for xerostomia. Additionally, he had good healing response during initial surgeries performed in soft tissues. During such procedures, patient's tissues proved to be feasible due to the substantial amount of bleeding observed in the mucosa and inner-bone surfaces after perforation for implant placement.

Experimental studies on the integration of implants in irradiated bone reveal that the integration in irradiated tissue happens at a slower pace. It has been recommended that the interval between implant placement and the second surgical procedure (reopening) must be extended to, at least, eight months.[19]

In terms of maintenance of osseointegration, three prospective studies assessed 744 implants placed in 206 patients who had been subjected to radiotherapy 3.5 and 14 years before. As the estimation of a time effect depends on the potential of radiotherapy for maintenance of osseointegration, those studies suggested an osseointegration rate that decreases with time: 93.9% in three years, 89.4% in five years and 78.0% in 14 years (744 implants, 206 patients).

Some researchers recommend adjuvant hyperbaric oxygen therapy (HBO) to increase the success of implant placement in irradiated patients. However, results are inconclusive and require highly developed devices, which increase the costs of treatment. Other studies yield good results, with a minimum implant loss rate for irradiated patients in spite of hyperbaric oxygen therapy.[2]

In addition to proper dental rehabilitation, masticatory function requires good mobility of the tongue, suction effect, appropriate soft palate and coordination of dental surfaces of the jaw. Only one third of patients subjected to implant-supported rehabilitation is able to recover masticatory function and deglutition. Dental restoration does not consist in providing benefits to mastication and nutrition only, but also to favor speech and facial esthetics. Furthermore, recovery of lower teeth properly directs salivary flow, whereas lower lip support increases salivary retention in the oral cavity.[5] The patient reported difficulties in mastication and deglutition, even after rehabilitation, due to decreased mobility of the tongue. Such fact hinders bolus positioning for food trituration during mastication and deglutition, causing the patient to drink a large amount of liquid while eating. On the other hand, he reported increased amount of saliva produced in the oral cavity, and clear weight gain after rehabilitation.

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## Conclusions

Dental surgeons must be aware of the side effects of radiotherapy as well as of the dose and waiting time before treatment onset so as to properly control osseointegrated implant treatment.

Osseointegrated implants can be safely employed in irradiated patients, provided that special care be taken.

Improvements in mastication, speech and esthetics promote patient's social reintegration, thus minimizing discomfort and suffering, in addition to optimizing therapeutic results and quality of life.

Carefully selecting patients, employing atraumatic surgical techniques and proper prosthetic rehabilitation are key to successful therapy.

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# The posterior maxilla: An update of anatomical notions based on advances in endosseous implant surface technology. A case report

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Alex Martins **GOMES****
João Lima **RODRIGUES***
Paulo Franco **TAITSON*****

## Abstract

**Objective:** Fixed implant-supported rehabilitation of the posterior maxilla is a challenge to dental professionals. Limitations of technique and material have established wrong concepts, especially with regard to bone classification. For instance, the concept of poor-quality bone has been associated with high rates of therapeutic failure because of implants with poorly evolved surfaces. A literature review on the embryological origin of tissues and the anatomy of the maxilla highlight the high regenerative ability of trabecular bone, which is rich in mesenchymal cells. **Methods**: The present report describes a case of failure of a machined-surface implant placed by osteotomy at the maxillary first molar region. The implant was replaced by a sandblasted, large grit, acid-etched SLA surface with a six-year survival rate follow-up. Clinical and radiographic assessments were performed every six months. **Results**: Data revealed implant osseointegration stability as well as tissue biocompatibility and prosthetic functionality. **Conclusion:** The literature on technically advanced implant surfaces suggests that the posterior maxilla is a safe and predictable site for fixed implant-supported rehabilitation.

**Keywords:** Maxilla. Dental implants. Osteotomy. Osseointegration. Anatomy.

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

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## Introduction

The development of Implantology as a dental specialty has resulted in new possibilities for the oral rehabilitation of edentulous patients, and, as a consequence, has made the outcomes of such treatments increasingly predictable.[1] However, the technology used in its early stages resulted in a high osseointegration failure rate, mostly due to the lack of interaction at the interface of contact between the bone and smooth or machined-surface implants. Some hypotheses have mistakenly associated structural deficiencies in certain craniofacial regions with implant failure. Such regions, particularly the posterior maxilla, have thus been classified as poor-quality bone.[2]

The posterior maxilla predominantly consists of trabecular or spongy bone. It is characterized not only by fast absorption of the alveolar bone after tooth loss, but also by maxillary sinus pneumatization, which usually worsens the prognosis of implant-supported rehabilitation. Moreover, the literature emphasizes the importance of the anatomical formation of the posterior maxilla and the advances in implant surfaces treatment.[3,4]

Bone classifications are being currently reviewed by studies that address technologically advanced implants, particularly those with rough, high-energy, hydroxylated, and bioactive surfaces. Such surfaces stimulate the migration and transformation of mesenchymal cells into osteoblasts, thus shortening the healing process and improving the predictability of implant-supported rehabilitation therapy in the posterior maxilla. In addition, implants are placed using non-invasive techniques, such as osteotomy.[5,6,7]

## Case report

The present case report describes the treatment performed on a Caucasian, 59-year-old, female, non-smoker patient in good overall health who required periodontal treatment and oral rehabilitation. After conservative periodontal treatment was performed, unfavorable elements of the anterior and posterior maxilla were removed, and fixed implant-supported rehabilitation was planned. After extraction of #24 and 26, machined-surface implants (Steri-Oss system, Yorba Linda, CA) were placed using 3.8 x 10 mm implant burs in the region of #25, and by means of osteotomy with a 4.5 x 8 mm implant installed in the region of #26. In accordance with the manufacturer's instructions, the healing cap was placed six months after the first procedure.

However, after a follow-up period of 20 months, osseointegration failed (Fig 1) at the second surgical stage, and the implant was covered by fibrous tissue (Figs 2, 3, 4, and 5). The affected area was subjected to scaling, and six months were allowed for healing (Figs 6 and 7). After this six-month healing period, a non-submerged wide-neck 4.8 x 8 mm implant with a sandblasted, large-grit, acid-etched surface (SLA® Straumann Dental Implant System, Basel, Switzerland) was installed in the same region by means of the same osteotome technique (Figs 8 and 9).

After a healing period of sixteen weeks (Figs 10 and 11), the patient was subjected to solid abutment fixation (Fig 12) with torque of 35 N and provisionalization. Masticatory load was established after eight months when implants were finalized with metal-ceramic crowns (Figs 13 and 14). Since then, the patient has been monitored every six months. Results were considered satisfactory after five years (Figs 15 and 16).

## Discussion

A wide body of scientific evidence supports the success of treatment using SLA surfaces[8] at the posterior maxilla.[9,10,11] Nevertheless, the literature still refers to bone classifications that describe the posterior maxilla as poor-quality bone. Such classifications are based on the results of the interaction between the bone and smooth or machined surfaces, which demand longer implants and a greater initial stabilization in the cortical bone. The classification of stabilization in

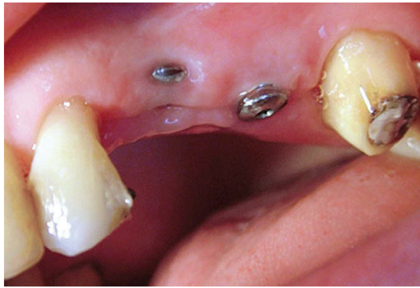

**Figure 1** - Failure in implant #26 osseointegration was observed after 20 months.

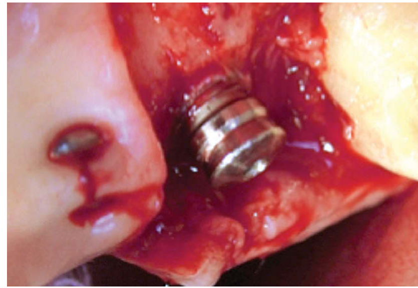

**Figure 2** - Implant removal without osseointegration.

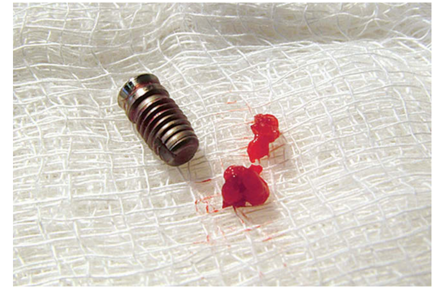

**Figure 3** - Removed implant and fibrosis associated with the machined surface.

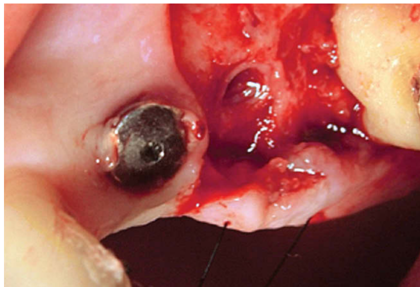

**Figure 4** - Fibrosis associated with the implant site.

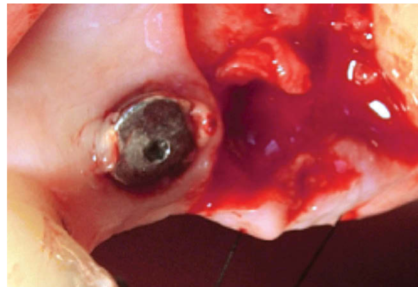

**Figure 5** - Removal of fibrosis.

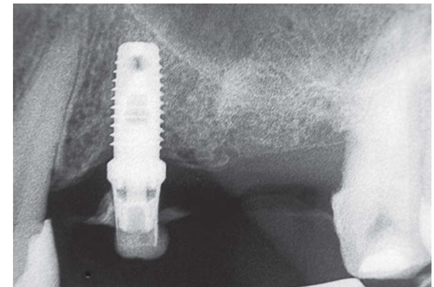

**Figure 6** - Radiograph showing healing six months after failure in implant #26 and the presence of machined implant surface of #24.

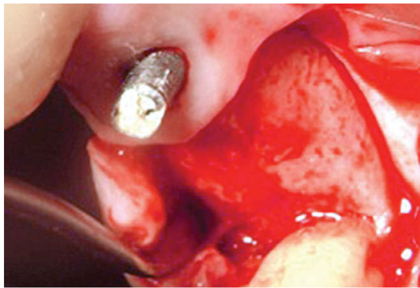

**Figure 7** - Complete bone repair after six months.

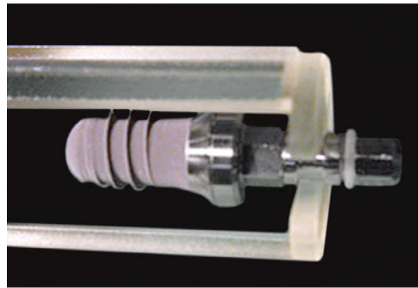

**Figure 8** - Straumann wide-neck 4.8 x 8 mm SLA Plus implant.

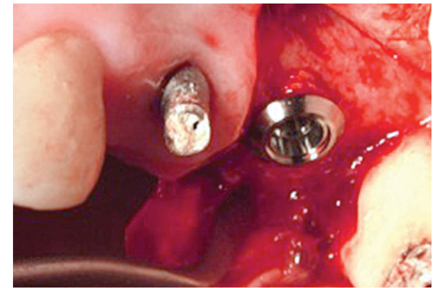

**Figure 9** - Implant placement by osteotomy.

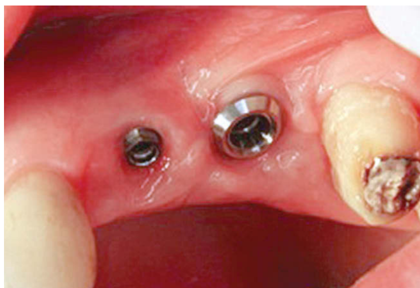

**Figure 10** - Sixteen weeks after healing.

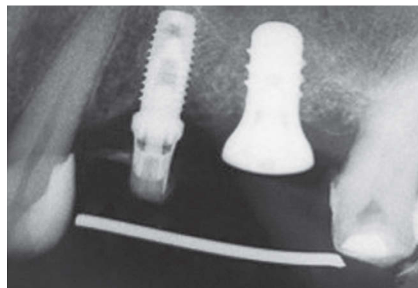

**Figure 11** - Radiographic image after healing.

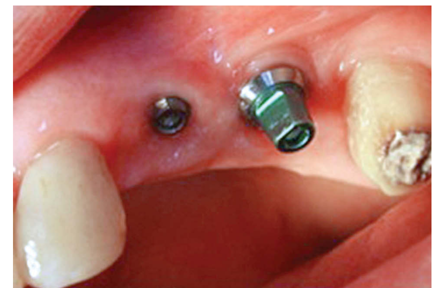

**Figure 12** - Solid abutment fixation with torque of 35 N.

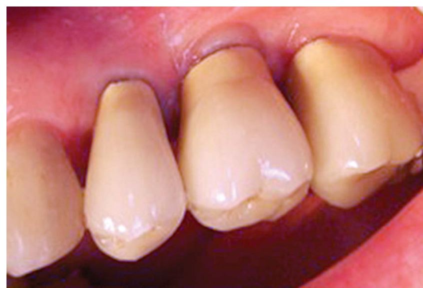

**Figure 13** - Fixed metal-ceramic restorations.

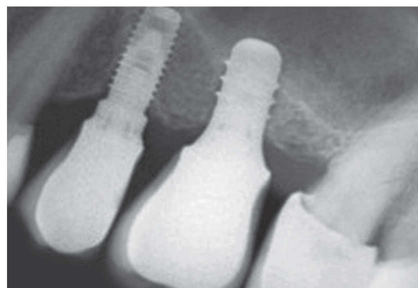

**Figure 14** - Radiographic image after restoration placement.

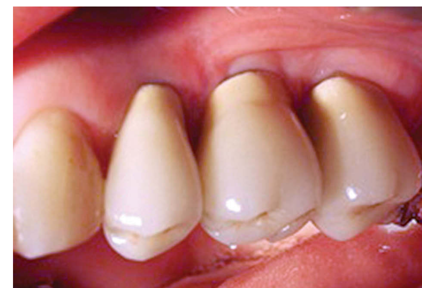

**Figure 15** - Metal-ceramic rehabilitation after five years.

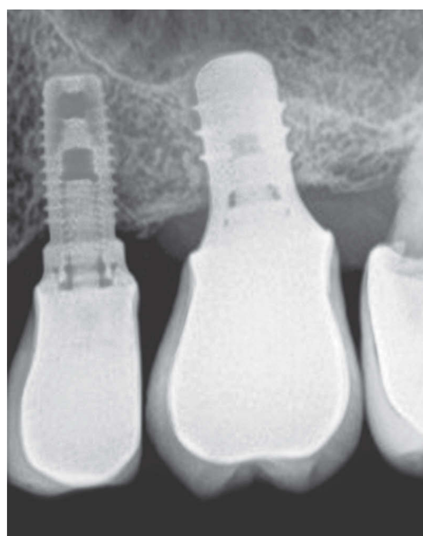

**Figure 16** - Digitized radiograph after five years. Note the Brägger index applied in the region.

the cortical bone is based on radiographic assessments and on the feeling of resistance that dental surgeons experience upon implant placement.[1,12]

As a function of the advances in the design and surfaces of implants, osseointegration is accomplished via the activation of mesenchymal cells which are found in large numbers at the posterior maxilla. Treated rough implant surfaces induce the transformation of the mesenchymal cells into osteoblasts, whereas smooth surfaces preferentially induce differentiation into fibroblasts.[13-16]

Rough-surface implants, such as SLA, exhibit higher surface energy and activate stationary mesenchymal cells at the treated region, promoting the fast formation of secondary bone and consequently increasing the predictability of treatment outcomes. They are placed with simple surgical techniques and are associated with lower degrees of morbidity. It is also important to emphasize the increase in bone height that is achieved at the region of the osteotomy and the SLA implant, as measured by Brägger's index.[2,5]

In an *in vitro* experiment, Kunzler et al[18] showed that the number of osteoblasts at the rough end of implants was almost two-fold greater than the number found at their smooth end, whereas the number of fibroblasts was almost three times higher at the polished titanium surfaces of rough surfaces.

In another *in vitro* experiment, Grösnerr-Schreiber et al[19] found a strong correlation between the number of fibroblast focal adhesion contacts (FACs) and surface roughness, with the highest number of FACs found on the surfaces with the lowest degree of surface roughness. Subcrestal placement of ITI implants showed that reabsorption occurs in the bone adjacent to the polished surface of implants, thus clinically confirming the results of the *in vitro* experiments.[18,20] The present case report shows the difference between the results obtained with the two approaches, and the follow-up analyses demonstrate the

degree of stability that was achieved in rehabilitation using an implant with an SLA surface. Consequently, scientific evidence and technological advances indicate a need to review the outdated bone classification system that rates the posterior maxilla as poor-quality bone. The results obtained from this study are similar to those presented by the current literature and suggest that the SLA surfaces are suitable for posterior maxilla.

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# Evaluation using FEM on the stress distribution on the implant, prosthetic components and crown, with Cone Morse, external and internal hexagon connections

Márcio de Carvalho **FORMIGA***
Ricardo Tatsuo **INOUE****
Raquel Virginia **ZANETTI****
Artemio Luiz **ZANETTI*****
Marcelo Luchesi **TEIXEIRA***
Flávio **TAKAMATSU******

## Abstract

**Objective:** The aim of this study was to compare the stress distribution between implant systems with different types of connections, i.e., external hexagon, internal hexagon and morse taper, by applying the Two-Dimensional Finite Element Method. **Methods:** A 100-N load was applied to the buccal cusp of an inferior second premolar in the axial direction and thereafter at an inclination of 45° on each system. Analysis was performed by means of the von Mises stresses criteria. **Results:** The results showed that in, all systems, the highest stress concentration occurred in the neck of the implant in contact with the cortical bone, except for the morse taper models, where the stress was concentrated in the inner portion of the implant in contact with the abutment. It also became apparent that oblique forces resulted in higher stress values than those obtained with axial loads. **Conclusion:** It could be concluded that abutment screws are the most fragile portion of the systems. Internal connection implant systems exhibited a more uniform distribution of stresses than external connection implant systems.

**Keywords:** Finite element method. Bone/implant connection. Von Mises stresses.

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

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## Introduction

Several different types of implants and connections are currently used. The most common ones are self-tapping cylindrical and tapered implants, both with external and internal hexagon connections. The latter are also available in the Morse Taper modality. However, all of them share the same constraint: given that implants have no periodontal ligament and are, therefore, directly connected to the bone, the load placed on top of the implant/prosthesis is directly transmitted to the bone.

In order to assess the distribution of forces exerted, both internally and externally, on the bone/implant/prosthesis, one can use finite element models to simulate and analyze the stress with utmost reliability by reconstructing mathematical models that depict bone tissue, implant and prosthesis.

The aim of this study was to evaluate — by the finite element method — the stress distribution that occurs in implants, abutments and crowns in different types of crown/implant connections (External Hexagon, Internal Hexagon and Morse Taper) under axial and oblique loads.

## Material and methods

The models developed for this study were constructed on the basis of the two-dimensional Finite Element Method. To assess the stresses that develop in the prosthesis/abutment/implant/bone support complex, models were fabricated so as to represent the relationship established between these structures. These models were created using three commercially available implants manufactured by Neodent (Curitiba, Brazil), all of which were self-tapping, had a cylindrical shape, and were made of commercially pure titanium. They were named Titamax I, with an external hexagon (EH), Titamax II, with an internal hexagon (IH), and a Morse taper connection implant (MT) named Titamax CM. All implants were 3.75 mm in diameter and 11 mm in length and received a tapered abutment prosthetic component. The prosthetic superstructures were made of nickel-chromium and the esthetic coatings were made from feldspathic porcelain manufactured by VITA, representing a second premolar. Each fixation sample was included in a block of orthophthalic unsaturated polyester resin, and was subsequently sectioned longitudinally in the buccolingual direction with a cooled KG Sorensen diamond disc half-way down the set comprising implant, connections, screws and prosthetic crowns without fractures and polished to improve alignment of the parts.

The dimensions of the crowns of the three types of implants were considered identical.

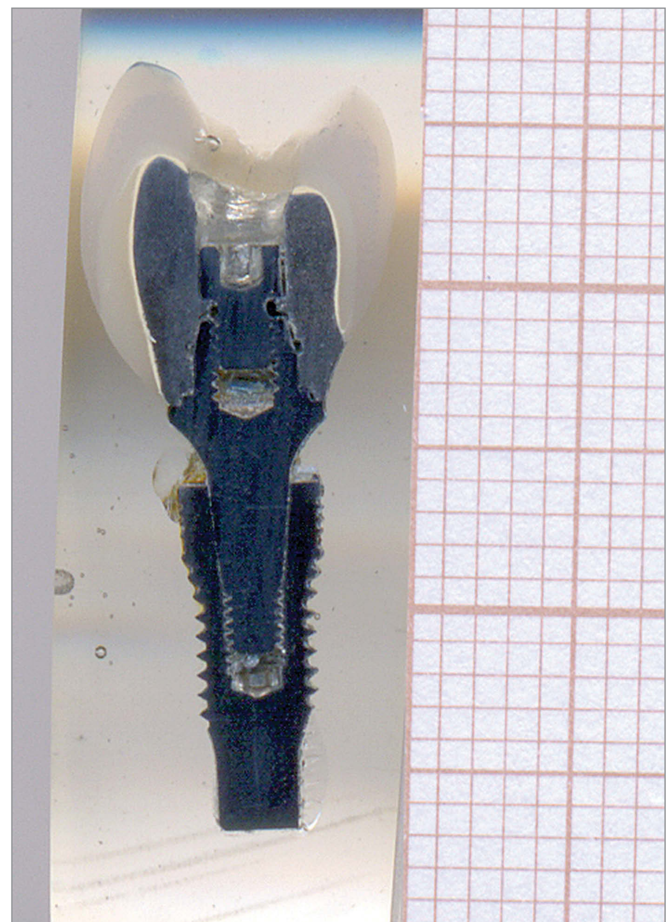


**Figure 1** - Longitudinal section of Morse Taper implant sample.

In the mathematical model developed for this research, a type II bone quality was established according to the classification of Lekholm and Zarb.[1] This physical condition was represented as a simulation feature by attributing mechanical properties to the bone. These properties were determined by the elastic constants known as elastic modulus and Poisson's ratio, as shown in Table 1.

Importing these drawings into Patran software made it possible to generate the finite element mesh for the different regions and attribute the different properties to the material. This modeling software also enabled the application of different loads and constraint conditions to the models.

The aim of this study was to evaluate the response of three types of implants (EH, IH and MT) to two loadings: A vertical load of 100 N and an oblique load of 100 N at 45º.

These loads were distributed across the region corresponding to the occlusal table of the crowns. Contact analysis was used in this study, as it allows relative sliding between abutment, retaining screws and implants when subjected to the action of an occlusal load, which allowed displacement to occur between the prosthetic pieces and the implant. The MT models were the only ones in which the inner region of the Morse Taper was used as a single body in contact with the inside of the abutment relative to the implant, with no contact. Thus, six virtual models were constructed with the following features:

a) Model 1: External hexagon with vertical load of 100 N.
b) Model 2: External hexagon with oblique load of 100 N.
c) Model 3: Internal hexagon with vertical load of 100 N.
d) Model 4: Internal hexagon with oblique load of 100 N.
e) Model 5: Morse Taper with vertical load of 100 N.
f) Model 6: Morse Taper with oblique load of 100 N.

**Table 1** - Mechanical properties of material comprising the models.

| Material properties | | | |
|---|---|---|---|
| **Components** | **Modulus of elasticity (MPa)** | **Poisson's ratio** | **Reference** |
| Porcelain | 68.9 | 0.28 | Anusavice et al[21] |
| Metal structure (Ni = Cr) | 203 | 0.30 | Suansuwan and Swain[22] |
| Crown screw (Ti) | 110 | 0.28 | Sakaguchi *apud* Sendyk[14] |
| Intermediate screw (Ti) | 110 | 0.28 | Sakaguchi *apud* Sendyk[14] |
| Abutment (Ti) | 110 | 0.28 | Sakaguchi *apud* Sendyk[14] |
| Implant | 110 | 0.33 | Richter et al *apud* Sendyk[14] |
| Medullary bone | 1.37 | 0.30 | Borchers and Reichart[7] |
| Cortical bone | 13.7 | 0.30 | Borchers and Reichart[7] |

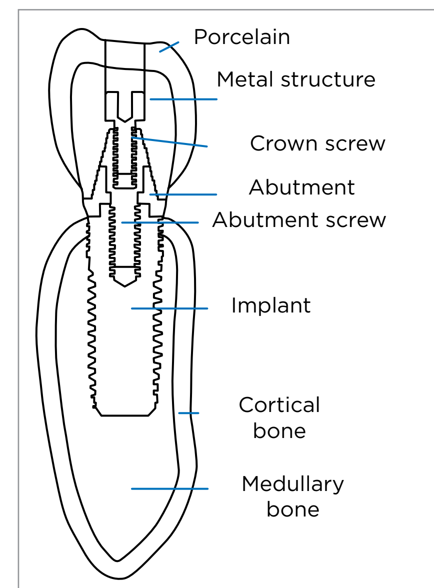



**Figure 2** - CAD drawing of Titamax I implant.

## Results

In model 1, the maximum stress occurred in the metallic infrastructure of the crown, and the second peak occurred in the abutment, more precisely on the base of contact with the implant, and near the cortical bone, on the same side where the load was applied. By changing load inclination, higher stress values were obtained in different structures other than what had been obtained with the vertical load. The highest stress value was found in the abutment screw, in its thinner portion above the threads, whereas the second highest stress value was found once again in the abutment, in the portion of contact between implant and the cortical bone, but on the face opposite to where the load had been applied.

In model 3, the maximum stress value occurred in the implant neck, while the second highest stress peak occurred in the abutment in the outer region, in contact with the implant/cortical bone junction in the same area where the load was applied. In model 4, the implant was the structure that exhibited the highest stress values, which were above and beyond the values observed in the previous (vertical load) system. The abutment screw received the second highest stress.

In model 5, the implant was the structure with the highest stress peak, with stress not concentrated in the neck region in contact with the cortical bone. The second highest value was found in the metallic structure of the crown, in the regions in contact with the abutment. In turn, in model 6, the structure that reached the highest stress value was the implant, concentrated in the region of the internal angle of the Morse taper in contact with the abutment, but hardly any stress was found in the neck in contact with the cortical bone. The second highest value was found in the crown screw.

The values for each structure are shown in the Table 2.

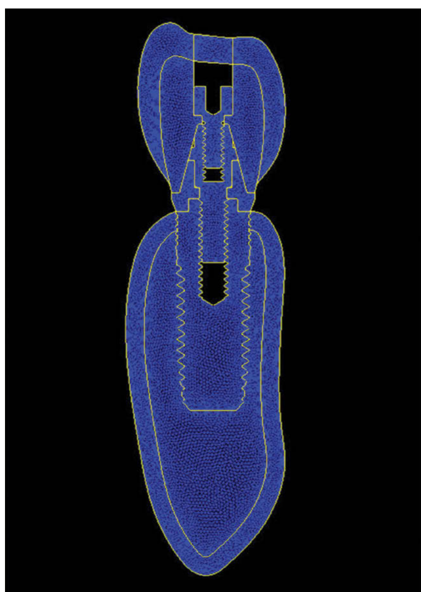


**Figure 3** - Model I mesh.

**Table 2** - Comparison of von Mises stresses in each structure of the systems evaluated.

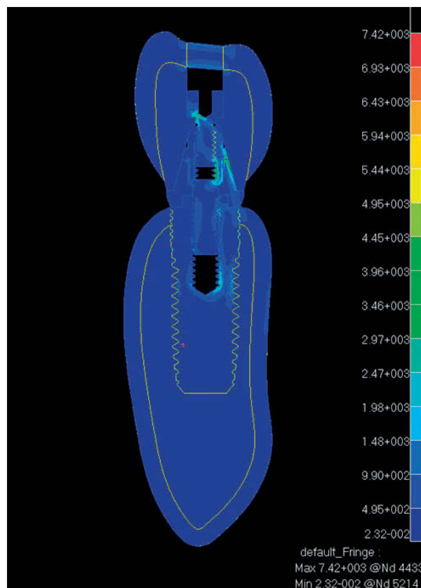
| Structure | Vertical EH | Oblique EH | Vertical IH | Oblique IH | Vertical MT | Oblique MT |
|---|---|---|---|---|---|---|
| | Maximum stress (MPa) | | | | | |
| Porcelain | 43.5 | 1590 | 36.5 | 622 | 39.7 | 597 |
| Metal structure | 176 | 1590 | 85.4 | 622 | 106 | 597 |
| Crown screw | 74.1 | 5820 | 34,5 | 1450 | 24.2 | 1400 |
| Abutment | 118 | 6260 | 141 | 812 | 100 | 847 |
| Abutment screw | 77.6 | **7420** | 67,9 | 1310 | | |
| Implant | 94 | 3580 | 212 | 1660 | 130 | 2200 |
| Cortical bone | 75 | 1010 | 96,5 | 706 | 42.6 | 642 |
| Medullary bone | 38.1 | 1350 | 25 | 302 | **22.1** | 251 |

## Discussion

The axial forces were more favorable due to stresses being more evenly distributed throughout the implant. The oblique forces produced stresses on the implant and bone that were more concentrated in the neck region. Ranger et al[3] and Alvarez-Arenal et al[2] reached the same conclusion regarding the direction of the loads.

Implants with internal connections showed more internally distributed lateral loads throughout implants, whereas the intermediate abutment screw had better protection. Binon[4] was the first to report that a greater length of the inner hexagon and a closer fit between its walls allow forces to be transmitted to the lateral walls of the implant. Indeed, when comparing stress peaks between abutments of the three systems under inclined loads, this investigation found that the IH implant showed the lowest stress values, corroborating Yang and Maeda.[5]

In comparing the systems with one another, the stress generated under oblique loads was considerably larger than under vertical loads. These results were identical to those found by Lehmann et al.[6] The highest stresses were observed in the region of the bone crest, especially when the implant was subjected to transverse loads. Unlike Borchers & Reichart[7] and Papavasiliou et al,[8] who found higher stresses in the cortical bone, in the present study, the cancellous bone experienced less stress than the cortical bone, except for the external hexagon (EH) system subjected to an oblique load of 45º and 100 N (Fig 4). When the External Hexagon system was subjected to a vertical load, the highest stresses were concentrated in the implant neck, especially on the side of force application, which also conveyed higher stresses to the cortical region in contact with the implant collar, and little stress to the cancellous bone. In contrast, under oblique loads, stresses were more evenly distributed across the body of the implant in the apical direction without concentrating too much strength on the threads. Still, a stress peak was noted in the neck of the implant as well, but in the opposite direction of force application. Stress transmitted to the cortical bone was also higher in this region, and increasingly distributed toward the apex,



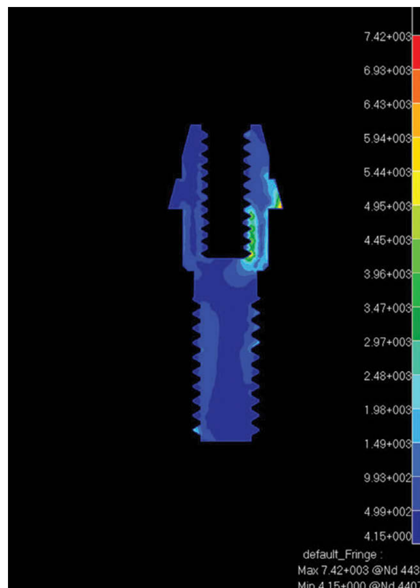




**Figure 4** - External Hexagon system under a 45º oblique load of 100 N.

**Figure 5** - External Hexagon system abutment screw under a 45º oblique load of 100 N.

although not as concentrated as when the vertical load was applied. The cancellous bone experienced increased stress with higher concentrations in the region opposite to that of load application, corroborating the findings of Rieger et al[9] and Meijer et al.[10] This system presented the biggest difference in stress values in comparing vertical *versus* oblique loads. These values were 95.6 times higher in the abutment screw of the oblique load system at 45° under load of 100 N (Fig 5) than in the vertical load system under 100 N.

The IH system showed higher stress values in the neck of the implant even when subjected to vertical load. However, stress was dissipated across the implant body in the apical direction. Likewise, stress was dissipated in the cancellous bone where stress was distributed throughout the region of contact with the implant. In contrast, in the cortical bone, stress remained more concentrated in the neck of the implant with values slightly higher than those of the External Hexagon. In spite of using a stepped, tapered implant, Fortuna's findings[11] were consistent with those found in this study. When the direction of the load was inclined, the stress on the implant became more concentrated at the neck of the implant, on the opposite side of force application, and was distributed nearly as far as the region where the abutment screw ends. Stress in the cortical bone was higher in the region of contact with the implant on the same side where it reached its highest stress, with the cancellous bone following the same pattern.

The Morse Taper system showed some differences. When subjected to a vertical load, the highest stress values were concentrated at the implant neck, although not in the region of contact with the cortical bone, but rather in the internal angle, in contact with the abutment, thus corroborating Barlattani and Sannino.[12] The value was found to be even lower than the IH value (Figs 6, 7 and 8). Internal stress gradually dissipated in the apical direction to the region where the abutment thread ends, and more so on the side where the force was applied. In the cortical bone, the stress was distributed in the apical direction, but below the values obtained in the other systems and load scenarios, more concentrated on the side where the load was applied. The same phenomenon occurred in the cancellous bone (Fig 9), i.e., the stresses spread throughout the implant region all the way to the apex, increasing on the side opposite to where the load had been applied. In subjecting the system to a load

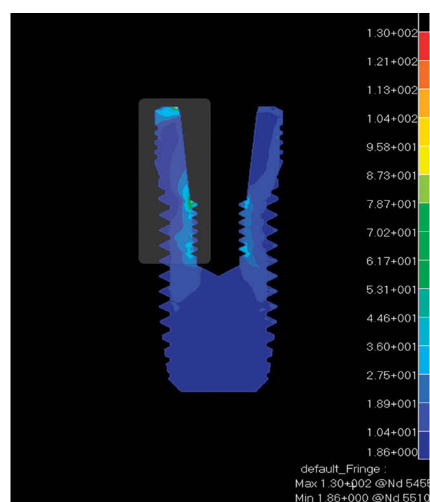



**Figure 6** - Morse taper implant under axial load of 100 N.

**Figure 7** - Morse taper implant cervical region under axial load of 100 N.

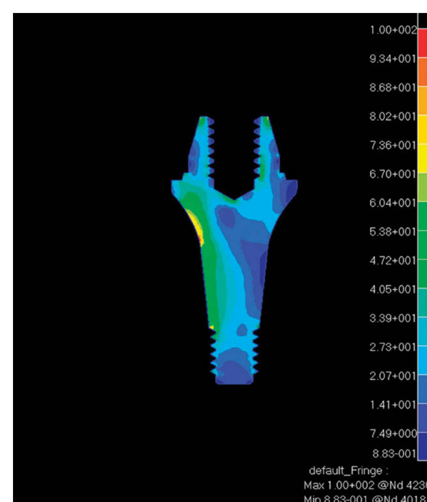


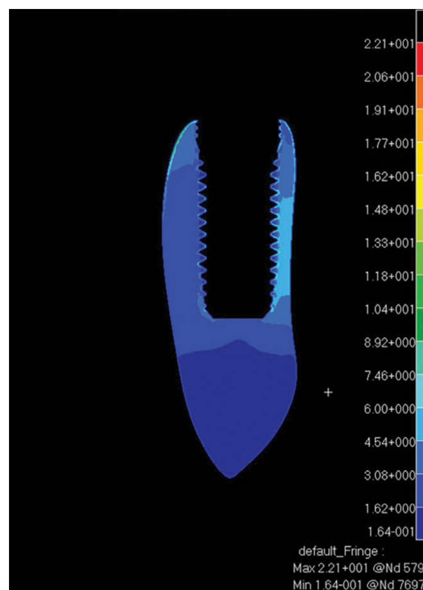

**Figure 8** - Morse taper abutment under axial load of 100 N.

inclined at 45º, stress distribution was similar to that of the vertical load. Such distribution, however, occurred on both sides of the implant, with virtually no stress in the neck of the implant in contact with the cortical bone. The stress in the cortical bone was not concentrated in the neck of the implant, but dissipated towards the apex, peaking on the lingual surface, without touching the implant. In the cancellous bone, stress was higher on the opposite side of load application, in the portion of contact with the first threads of the implant. It gradually started moving away from the implant, and eventually dissipated towards the implant apex. Similar results were found by Tabata et al[13] in a study using 3D FEM to compare models based on the concept of reduced and conventional platforms.

In evaluating the abutments, vertical loads consistently yielded higher stress concentration at the base of the abutment, in the region where the load was applied in contact with the neck of the implant and cortical bone, showing a tendency of the crown to shift to the lingual side. The crown screws had stresses distributed through the threads and screws of the abutments just below the neck, in the thinner portion of the screw. In applying oblique loads to the crown screws, the stress was higher in the neck of the screw on the buccal side. The same occurred with abutment screws in thinner areas. The values obtained with oblique loads were consistently higher than with vertical loads. This result confirms the findings of Sendyk,[14] Pantoja[15] and Alkan et al.[16]

Corroborating the study by Khraisat et al,[17] the External Hexagon implant yielded the lowest stress values when subjected to vertical loads, whereas Internal Hexagon implants yielded the lowest stress values when subjected to inclined loads. In comparing the results obtained with cortical and cancellous bone, the Morse Taper system showed lower values under both vertical and inclined loads, validating Bozkaya et al.[18]

Merz et al[19] reported that Morse taper implants feature a superior mechanism that ensures better connection stability in the long term. Given that in the Morse taper system investigated in this study the abutment forms a single piece with the intermediate abutment fixation screw, no comparison can be made between the abutment screws, and therefore the whole set was



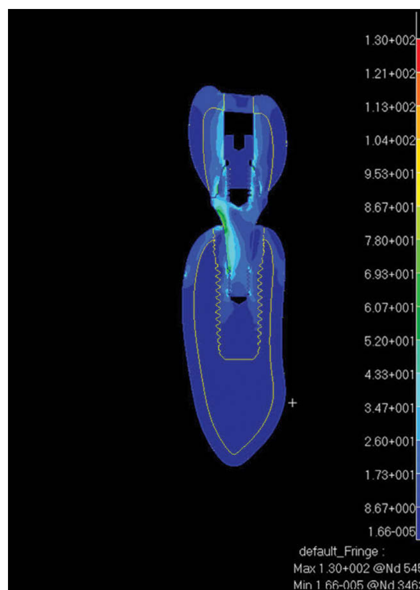




**Figure 9** - Medullary bone of Morse taper system under axial load of 100 N.

**Figure 10** - Morse taper system under axial load of 100 N.

defined as the intermediate abutment. Likewise, the Morse taper system under a vertical load yielded the lowest value among the three abutments, and the second highest under an oblique load, but with little numerical difference in terms of the lowest value, which was achieved by the Internal Hexagon. The difference in terms of thickness, however, became quite clear, i.e., Morse taper was much thicker than the other systems as it did not have a separate screw. For this reason, it should be more resistant to fractures and more stable, in addition to displaying little or no micromotion whatsoever (Fig 10). As argued by Xia et al,[20] the factors mentioned above combined with an absence of load concentration in the bone/implant interface can partly explain why this connection showed better results in terms of marginal bone loss around implants.

## Conclusions

According to the findings of this study, it is reasonable to conclude that the levels of von Mises stress were always higher in models subjected to oblique loads *versus* vertical loads, both in the set as a whole and when each structure was measured separately. When the External Hexagon model was subjected to an oblique 45° load, it showed the highest levels of stress in both cortical and cancellous bone. Furthermore, the structure of this particular model had the highest stress values internally, in the abutment screw. Implants with a reduced platform design seem to generate less stress in the cortical bone, which may contribute to less bone loss in this region, but further studies are warranted to investigate this assumption.

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# A retrospective clinical trial of the early success rate of osseointegrated implants

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## Abstract

**Introduction:** Dental implants have become an alternative to treat edentulism, however, some variants involving the implant itself and the receptor site can hinder treatment success. Dental implant failure is classified into late or early, depending on when it occurs. **Objective:** To determine the early success rate of implants installed during a specialization course in Implantodontics carried out between 2009 and 2012. **Methods:** The records of patients treated between 2009 and 2012 were analyzed. The following inclusion criteria were applied: P-I Brånemark Philosophy implants installed by means of the two-stage surgical technique, with implants submerged for a minimum period of three months. The selected patients underwent implant placement in the maxilla and mandible, subjected or not to bone graft. Evaluation was implemented at implant reopening. Implant survival after prosthetic loading was not considered. **Results:** The success rate was of 97%, with the presence or absence of bone graft, with implant positioning significantly influencing the final results. **Conclusions:** The success rate observed by this study not only corroborates the literature, but also reveals that the operator's experience does not necessarily interferes in treatment outcomes. The findings also show that the posterior region had the highest number of failures, whereas bone graft sites had a higher success rate in comparison to other studies.

**Keywords:** Dental implant. Osseointegration. Epidemiological studies.

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## Introduction

With the development of Implantodontics, osseointegrated implants have become the first option for treating edentulism. In this context, new techniques and material have been continuously developed to promote osseointegration in an effective, stable, early and lasting manner.

However, some factors negatively affect the success of this type of rehabilitative treatment, among which is the relationship between the characteristics of implant *versus* receptor site.[14] The inherent characteristics of implants are: surface treatment, morphology and biocompatibility.[1,18] As for the receptor site, bone quality and amount are key for treatment success. Furthermore, the surgical technique, initial stability of the implant, the surgeon's experience and reverse planning should also be analyzed.[14,18] The presence or not of systemic changes and harmful habits that may hinder bone-implant interaction should also be considered.[10]

Implant failure is classified into early or late. The former happens before an implant fulfills its function, i.e., it is related to the healing process. The latter happens after chewing efforts are required, thus characterizing a breakage of a pre-existing osseointegration.[10]

In this context, the objective of this study was to establish the failure rate of implants installed during an specialization course in Implantodontics of the Brazilian Association of Dentistry (Cascavel/PR), between 2009 and 2012.

## Material and Methods

The records of patients treated in the specialization course of the Brazilian Association of Dentistry (Cascavel/PR) between 2009 and 2012 were analyzed. The study included males and females aged between 18 and 70 years.

The following inclusion criteria were applied: PI Brånemark Philosophy™ implants (Exopro, Campinas/SP, Brazil) installed by means of the two-stage surgical technique. These implants, developed by professor Per-Ingvar Brånemark, present the following characteristics: cylindrical and symmetrical body with round threads and decreasing depth minimized to the apex; semi-rugous surface with circular and irregular micro threads with depth of 1 $\mu$m to 5 $\mu$m, exposed to subtraction by mechanical ultra cleaning; tapered apex with threads; central opening and distal chambers with three or four inputs responsible for the functional management of bone tissue; and nanometric topography.[6]

The following exclusion criteria were applied: patients with incomplete records; those who had not yet been submitted to the second surgical phase; patients whose implants were installed in one surgical phase, only; or who gave up treatment.

The selected patients underwent implant placement in the maxilla and mandible, subjected or not to bone graft (autogenous, homogenous or xenogeous). Autograft had the mandibular ramus, mentum, tuberosity of the maxilla or cranial vault as donation sites. BioOss lyophilized bovine bone (Geistlich Pharma of Brazil, São Paulo, SP, Brazil) and bone grafts from bone bank were also used. Patients' preoperative preparation included antibiotic prophylaxis with 1 g of amoxicillin and preemptive analgesia with 4 mg of dexamethasone.

After analysis and planning of cases and procedures of asepsis and antisepsis, implant placement was performed under local anesthesia with 4% Articaine with epinephrine 1:100,000 through full thickness mucoperiosteal flap. Receptor site preparation was carried out with drills provided by the manufacturer whose instructions were strictly followed. After implant placement, suture was performed with 4-0 Nylon, with implants submerged for a minimum period of three months and a maximum period of 26 months.

Data collection included information about: patient's age and sex; underlying diseases; smoking habits; number of implants; implant loss; previous bone graft procedures, material and donation site; reopening and implant loss time.

Evaluation was implemented at implant reopening. Implant survival after continuous chewing efforts was not considered. According to Albrektsson and Zarb's adaptation,[1] implants were considered successful when meeting the following criteria: absence of painful symptoms, absence of persistent infection and absence of clinical mobility in any direction after reopening. Implants were monitored for 30 days after the prosthetic crowns had been installed.

Data were analyzed by means of absolute (n) and relative (%) frequency values, as well as by the parameters of mean and standard deviation. Fisher's exact test and chi-square test were used to verify the association between the qualitative variables and the implant outcomes. Student's "t" test was used to compare the "Success" and "Failure" groups with the quantitative variables. Significance level was set at 5% ($P < 0,05$) for all tests, with statistical procedures carried out in the SPSS software (version 13.0).

## Results

This analysis was based on the assessment of the medical records of 132 patients, 93 women and 39 men aged between 18 and 70 years old, with a mean age of 47.33 years. A total of 430 implants were analyzed, with 13 cases of failure (Fig 1). Among these, 193 implants were inserted in the maxilla (44.8%) and 237 in the mandible (55.1%), with 307 installed in the posterior region and 123 in the anterior region. All cases of failure occurred in the posterior region (Table 1). Despite these findings, the result was statistically insignificant ($P = 0.190$; chi-square) due to the small number of failures. The minimum period for reopening was of three months, whereas the maximum was of 26 months, with an average of 7.90 ± 3.89.

Non-grafted areas received 399 implants (78.8%), whereas grafted sites received 91 implants (21.2%). Additionally, 63.7% of bone grafts were block grafts, 35.2% sinus lift and 1.1% particulate grafts. The most prevalent donation site was the menton, followed by the mandibular ramus. Implant loss comprised 4.4% of the sample (Fig 3), with statistically significant difference in comparison to implants installed in areas without bone graft ($P = 0.287$; Fisher's Test).

Out of the total, 143 (33.3%) implants were distributed among patients with systemic changes (Fig 2) of which the most prevalent was hypertension (31.72%). Seven implants were installed in patients with diabetes mellitus (1.6%), with only one case of failure (14.28%). However, due to the limited sample, this data is statistically insignificant ($P = 0.236$; Fischer's Test). Smokers accounted for 1.2% of implants, without any failures ($p = 0.857$).

## Discussion

Dental implant failure is classified into early or late, depending on the moment when failure occurs: before or after prosthesis placement. According to Misch et al,[12] an

**Table 1** - Association between implant topographic location and final outcome.

| | | | Result | | Total |
|---|---|---|---|---|---|
| | | | Success | Failure | |
| Topographic location | Lower anterior | n | 42 | 0 | 42 |
| | | % | 100.0% | 0.0% | 100.0% |
| | Lower posterior | n | 188 | 7 | 195 |
| | | % | 96.4% | 3.6% | 100.0% |
| | Upper anterior | n | 81 | 0 | 81 |
| | | % | 100.0% | 0.0% | 100.0% |
| | Upper posterior | n | 106 | 6 | 112 |
| | | % | 94.6% | 5.4% | 100.0% |
| Total | | n | 417 | 13 | 430 |
| | | % | 97.0% | 3.0% | 100.0% |

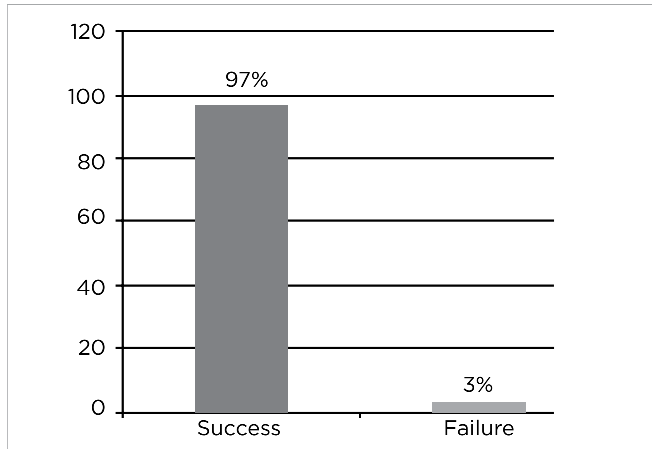


**Figure 1** - Success rate of the analyzed implants.

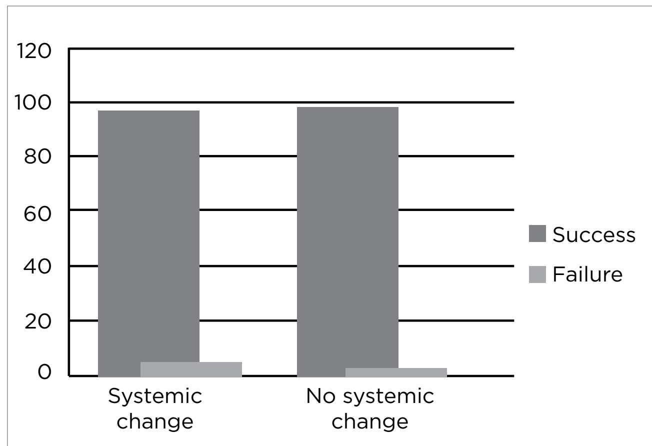


**Figure 2** - Results obtained in patients with systemic diseases.

**Figure 3** - Success rate of implants installed in areas submitted to bone graft.

implant is considered successful in the absence of mobility at the time of reopening and beginning of the prosthetic phase, absence of radiolucent radiographic image adjacent to the implant and when suppuration or symptomatology associated with the implant are not present. The potential risks of early failure include bone amount and quality, receptor site, presence of bone grafts, genetic predisposition, metabolic disorders, smoking habits,[4,21] implant biocompatibility and morphology, and surgical technique.[1,5] As for late failure, we can also add planning and development of the prosthetic phase.[13,18]

Some authors claim that systemic changes can affect treatment success, however, the subject is still controversial.[12,13] Although it has been suggested that the presence of diabetes mellitus, even in compensated patients, can affect implant survival, no conclusive data is able to prove such interaction. In this study, failure was observed in 14.28% of implants inserted in diabetes mellitus patients, however, due to the limited sample, data was not significant. Other studies have recently reported that cardiovascular diseases do not affect implant failure, especially early.[13]

The histological changes that promote osseointegration are activated by local aggression of the alveolus during surgical preparation. Tissue repair happens as a result of blood clot formation between the surface of the implant and the bone wall, where mesenchymal cells differentiate themselves into osteoblasts or fibroblasts, thus promoting bone integration or formation of fibrous scar, respectively.[17,20] Primary stability is essential for this process and results from bone quality and amount, implant geometry and the surgical technique.[3,17] Smoking habits negatively interfere in bone quality. The negative action of tobacco is mainly related to peripheral vasoconstriction and decreased blood flow, directly affecting the initial phase of healing. In addition to vasoconstriction, nicotine increases platelet aggregation as well as fibrinogen and hemoglobin

levels, and hinders neutrophil and leukocyte activities, thus affecting the healing process.[21]

The literature demonstrates that smokers have a higher implant failure rate,[9,14] especially when installed in the maxilla.[14] However, Baqain et al,[4] claim that tobacco alone is not a significant risk factor. Sverzut et al[21] and Ardekian et al[3] assert that tobacco is not considered a statistically significant risk factor for early implant failure. In the present study, five implants were installed in patients with smoking habits, without cases of failure. However, due to a limited sample, this fact proves to be inconclusive.

Success rates vary considerably in the literature. In spite of favorable conditions, a small number of implants is fated to failure.[17] Oliveira[14] mentions that the success rate for single dental implants ranges from 91 to 98.5%. Serrão et al[18] found a success rate between 97.3% and 98%, varying according to the implant surface treatment. According to Canullo et al,[6] the survival and success rates of late implant placement and load range between 96.3% and 96.5%, whereas with immediate loading the percentages vary from 97.1% to 97.7%. In the study conducted by the authors, the index was of 96.64%. A study conducted by Olate et al[13] found a success rate of 96.2% for 1649 implants. Sverzut et al,[21] AlGhamdi[2] and Olate et al[13] affirm that early failure affects approximately 1.5% to 21% of implants. Baqain et al[4] assert that early failure rates vary from 0.7% to 3.8%. The present study, which evaluated 399 implants, found a failure rate of 4%. In agreement with data provided by the literature, the present study presented a success rate of 97%. Alghamdi[2] reports that surgical trauma seems to be the most common cause of implant failure.

The surgical technique may be affected, among other factors, by the ability of the operator. Some authors have pointed out that the surgeon's skills are directly related to implant loss, especially when early failure is taken into account.[9,14] In contrast, other authors claim that this variant does not affect final treatment outcomes. More recent studies have evidenced that the surgeon's experience does not influence implant success rates.[10] These statistics can be explained by the technological innovations of implants and surgical techniques[20] and by the supervision of experienced and trained professionals during specialization courses on surgery. This study corroborates with those authors and, in association with the literature, assumes that the success rate of implant placement carried out by experienced professionals is statistically similar to that achieved by undergraduate professionals, thus demonstrating that the success rate seems to be more influenced by other factors. Likewise, Oliveira[14] reached levels similar to those of other analyses, which suggests that students' education during the specialization course is enough to provide the patient a satisfactory treatment from a functional and esthetic point of view.

The receptor site can also affect implant success. For Alghamdi,[2] the areas with greater losses are, respectively, the anterior region of the maxilla, posterior region of the mandible, posterior region of the maxilla and the anterior region of the mandible. According to Baqain et al,[4] bone types I and IV are more likely to present early failures. However, Olate et al[13] assert that implant positioning in the maxilla and mandible does not generate statistically significant differences. For these authors,[13] bone quality is not related to early implant loss, being more closely linked to late loss. They analyzed 1628 implants and found no statistical differences in implant success installed in the mandible or maxilla, however, implants installed in the anterior region showed a higher failure rate (4.3%) when compared with implants installed in the posterior region (2.8%). In the study by Canullo et al,[6] failure reached a rate of 2.85% for implants installed in the mandible and 3.8% for implants installed in the maxilla. In the same research, 528 implants were inserted in the mandible, with 11 cases of posterior failure (3.14%) and four cases of anterior failure (2.25%). A total of 633 implants were

installed in the maxilla, with 24 cases of failure: 13 in the posterior region (4.02%) and 11 in the anterior region (3.56%). Differently from data found in the literature, out of the failures found in this study, seven occurred in the mandible (3.6%), six occurred in the maxilla (5.4%), and all of them occurred in the posterior region.

Rehabilitation with osseointegrated implants require minimal bone amount to achieve stable anchorage. Some cases even require previous bone graft. Nevertheless, implant placement in bone-grafted sites have lower success rates in comparison to non-grafted sites,[7,15] probably due to poor vascularization and the lower amount of cells in grafted bones.[15] The literature shows that the success rate of implants inserted in grafted areas varies from 49% to 100% in the maxilla, and between 61% and 98% in the mandible.[7] The study conducted by Serrão et al[18] revealed a success rate of 97.8% for implant placement in non-grafted areas, whereas the index found in grafted areas was of 80%. Canullo et al[6] examined 1,161 implants, out of which 39 failed (3.36%). 135 had been inserted in grafted areas, with a failure rate of 5.19% (7 cases of failure). The present analysis had a success rate of 97.3% for implants inserted in non-grafted areas, and a rate of 95.6% for grafted areas, thus contradicting data from the literature which demonstrate higher failure rates for grafted sites.

Surface treatment may also be related to implant success.[5,20] The topographical modifications vary in micro and nanometric scales.[11] Some studies revealed that implants subjected to these processes have an increased bone contact,[11] thus providing more intense osseointegration and, as a consequence, shortening waiting time and allowing early loading.[20] However, other authors did not identify differences in bone response for implants with micro or nano-topography. Thus, the benefit of nanometric modification of implant surface is still controversial,[5] however, the literature confirms that surface treatment generally improves the response of osseointegration when compared to machined surface implants.

As for early implant loss, infection can be considered as one of its main causes.[8,16,19] The infection rate varies from 1% to 3%,[3] and, for this reason, several antibiotic therapies have been recommended to decrease the risk of complications.[16,19] Nevertheless, the use of antibiotics includes risks.[19] Thus, the antibiotic of choice should not only have the least possible side effects, but also to be effective against the main bacteria responsible for infection.[8] According to Ardekian et al,[3] antibiotic prophylaxis reduces the risk of infection in 50% of cases. Karaky et al[18] evaluated three therapeutic regimens: antibiotic prophylaxis; postoperative use of antibiotics; as well as pre and postoperative antibiotic therapy. No statistical differences were found among the three groups, thus concluding that the therapeutic regimens to be adopted should be limited to prophylaxis, as the latter reduces the costs and the possibility of bacterial resistance. However, from a methodological point of view, a fourth group (control group) should have been employed, without the use of any antibiotic regimen, so that the real need for systemic antibacterial agents could be evaluated.

The overall failure of endosseous implants varies from 1.9% to 3.6%.[14,18,20] Early failure happens due to some interference in the healing process, whereas late failure occurs due to a difficulty in maintaining the pre-established osseointegration.[1,3,21] The prevalence of early failures (approximately 1.9%)[18] is higher in young and healthy women and evolves with less bone loss when compared to late failure.[10] The main cause of these cases is failure in osseointegration. Late failure (3.6% to 4.3%)[18] is related to male patients of more advanced ages, with higher prevalence of systemic problems in addition to moderate to severe bone loss, which makes treatment more complex.[10] The main reasons of late failures are: peri-implantitis, occlusal overload and implant fracture.[9,10]

## Conclusion

The success rate obtained in this study corroborates the literature and evidences that the operator's experience does not necessarily affects final treatment outcomes. The findings also demonstrate that the area with the greatest failure rate was the posterior region and that bone-grafted sites showed higher success rates in comparison to other analyses. However, due to the limited sample, additional studies are warranted to further investigate these variants.

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# Immediate implant in inter-radicular septum area: Case report

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Mariela Francisco Machado **ROSA***
Artur Breno Wanderley **ALÉCIO***
César Augusto Magalhães **BENFATTI****

**Abstract**

**Introduction:** The purpose of rehabilitation after tooth loss is the optimal healing of soft tissues around the prosthesis so that an adequate emergence profile can be achieved. Excessive handling of these tissues may be avoided by using existing bone. **Objective:** This case report describes the atraumatic extraction of a fractured mandibular first molar and the immediate placement of an implant in the inter-radicular septum. **Methods:** The atraumatic technique and the immediate placement of the implant preserved hard and soft tissues in the extraction site. **Results:** The patient had no clinical evidence of complications, the definitive implant-supported prosthesis was immediately placed. The adaptation of peri-implant tissues was satisfactory; function and comfort were restored, and, above all, tissues were preserved.

**Keywords:** Mandible. Dental implants. Tooth extraction.

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## Introduction

Implantology has added great predictability to the rehabilitation of lost teeth and given patients treatment alternatives to achieve satisfactory results and a balance between esthetics and function of both posterior and anterior teeth.[1]

Immediate implant and loading techniques may help to achieve satisfactory esthetic results, as their purpose is to promote healing of soft tissues around provisional prosthesis, which should already have the correct emergence profile and, therefore, do not require much handling of tissues during definitive surgeries and gingival recontouring. The fundamental preservation of support tissue integrity during extraction has been associated with atraumatic techniques, as well as familiarity with and observation of biological principles of bone repair. The extraction of a tooth triggers natural healing, which inevitably induces bone wall remodeling and resorption.[3,4,5] The alveolar process, a tooth-dependent tissue, develops at the same time as teeth erupt and is primarily made up of bundle bone. Its volume, as well as its shape, is defined by its format, eruption axis and possible tooth inclination.[6] After tooth extractions, bone resorbs because of osteoclasis, which results in substantial vertical and horizontal reductions of the buccal crest.[7]

Alveolar bone resorption, in addition to posing an esthetic problem when fabricating the definitive implant-supported prosthesis, also makes it difficult or impossible to place the implant in the correct position. Immediate implants may ensure that the relationship between peri-implant tissues and healing tissue preserves pre-surgical gingiva and bone aspects.[8] Therefore, a mucoperiosteal flap does not have to be raised; when it is raised, there is additional osteoclastic resorption in the external aspect of the buccal bone plate, particularly when the patient has a thin periodontium.[9]

## Case report

This case report describes the placement of an implant in the region of tooth # 46 of a 61-year-old woman in good systemic health. The patient was referred to the clinical service of the Dental Implant Study and Research Center of the Federal University of Santa Catarina (CEPID-UFSC) for extraction and implant placement in the region of tooth # 46 (Fig 1).Clinical examination revealed that the periodontium was healthy. CT scanning showed good bone amount and quality for the placement of an osseointegrated implant. According to surgical and prosthetic planning, rehabilitation included an immediately placed implant and a screw-retained and cemented implant-supported prosthesis placed after osseointegration. Atraumatic extraction of the tooth (Fig 2) was performed by means of root section and use of a periotome to preserve buccal and lingual bone walls, as well as the interradicular septum. In addition, no mucoperiosteal flap was raised to avoid buccal wall resorption, which may result from periosteal flap

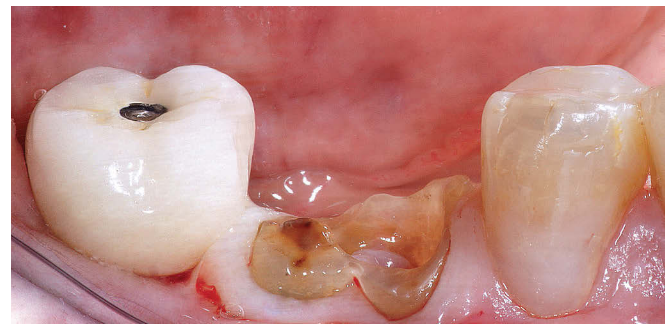

**Figure 1** - Tooth # 46.

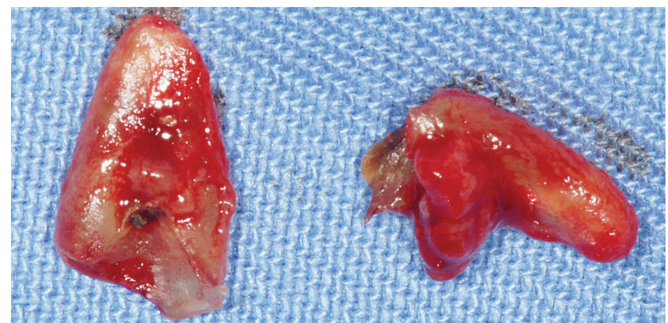

**Figure 2** - Tooth extraction.

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raising (Fig 3).After extraction, the socket was curetted and perforated for implant placement. The external hex implant had a cylindrical body (Neodent Titamax cortical, Brazil) and a regular platform and measured 4.0 x 11.0 mm. The surgical technique used was anchorage of the implant in the intra-radicular septum (Fig 4) to obtain a good surgical and prosthetic positioning in addition to primary stability (Fig 5). The sequence of drills was the one recommended by the manufacturer, but they were used conservatively to avoid fenestration of the septum walls and the consequent loss of implant primary stability.

After the implant was torqued to 40 N and the cover screw was placed, the extraction sockets were filled with a bovine bone graft composed of an inorganic bone marrow portion and an organic cortical portion. The purpose of this filling was to preserve the architecture of the bone and gingival tissues (Fig 6). To close the surgical wound, the buccal flap was slightly divided for greater mobility and to achieve primary closure using simple suture.

Five months later, the cover screw was exposed and a healing cap was placed to keep separation from the peri-implant mucosa. Seven days later, procedures for definitive prosthesis were started. As the implant was at a posterior site with low esthetic demands, no tissue recontouring was necessary. One month later, the implant-supported prosthesis was placed, and the adaptation of peri-implant tissues was satisfactory (Fig 7).

## Discussion

The thickness of the buccal bone wall may significantly affect its resorption pattern. A minimum thickness of 2 mm of buccal bone seems to be necessary to keep a stable vertical dimension of the alveolar crest and ensure support to soft tissues. If this minimum requirement is

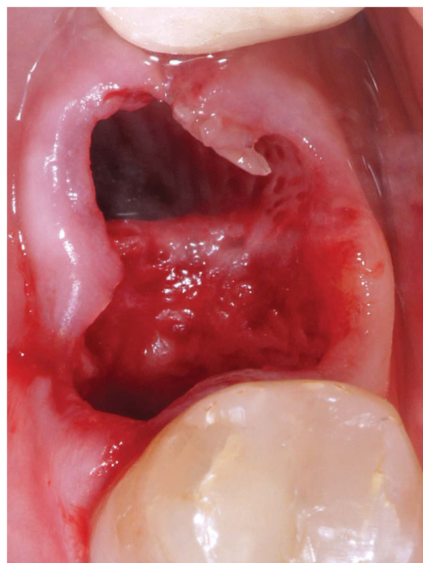

**Figure 3** - First molar extracted without sectioning or damaging the inter-radicular bone.

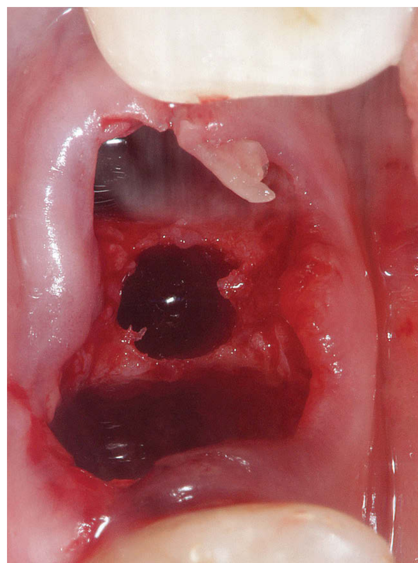

**Figure 4** - Preparation and osteotomy of inter-radicular bone for later implant placement.

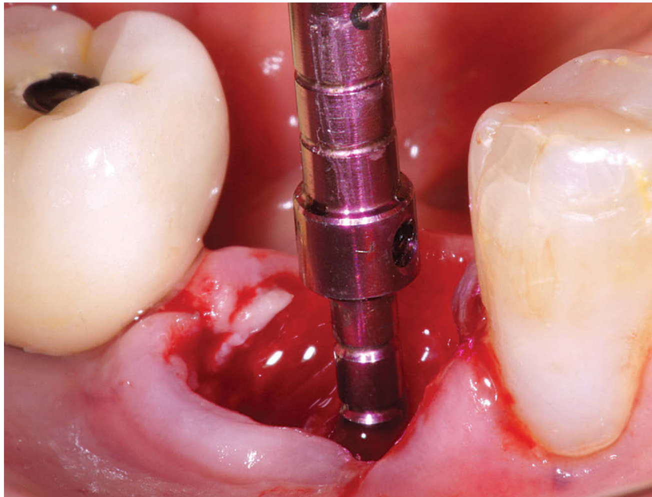

**Figure 5** - Placement of surgical guide.

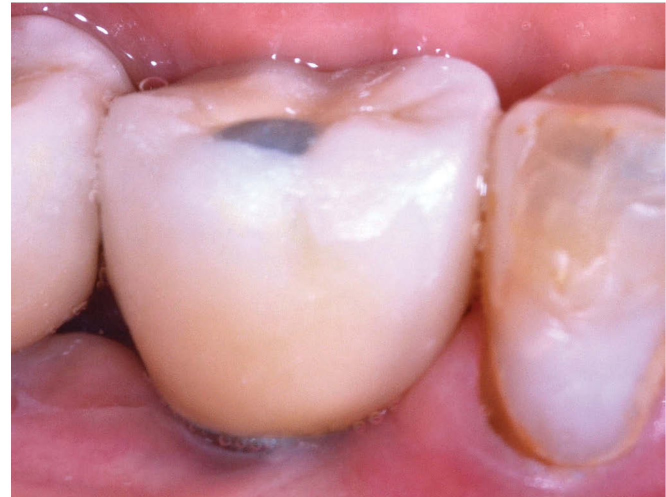

**Figure 7** - Definitive prosthesis

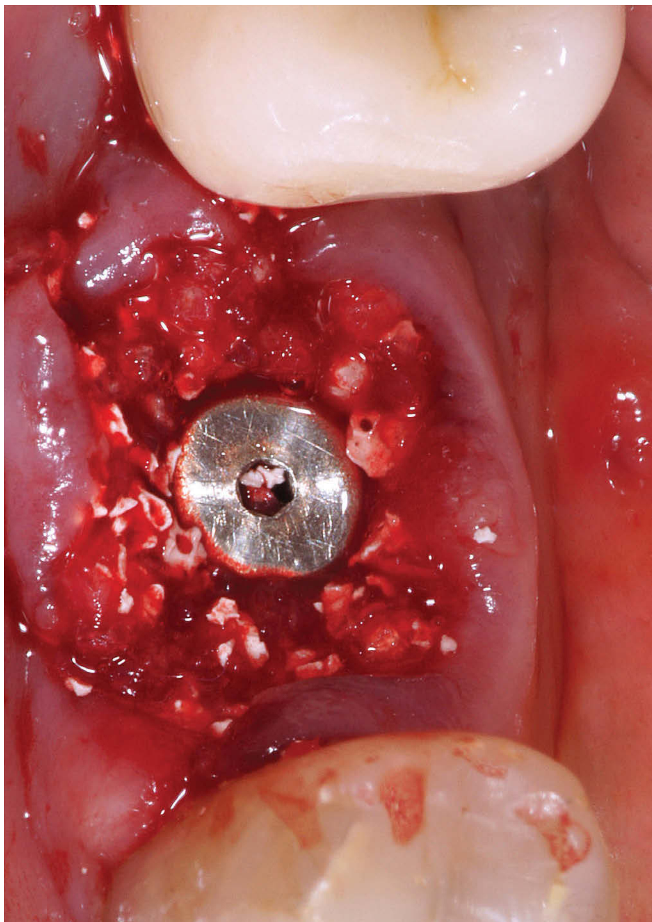

**Figure 6** - Implant placed in inter-radicular area achieved primary stability after adequate preparation and filling.

not met, socket filling (before or during implant placement) should be adopted to try to achieve the minimum thickness required.[10]

A multi-site randomized controlled trial evaluated the vertical dimensions of the bony walls of 93 patients and used those results as references. The patients had anterior teeth extracted and received immediate implants in the esthetic zone. Results revealed that most buccal bone walls (93.5%) had thickness of 0.5-1.5 mm. Only 6.5% had a thickness of 2 mm or greater. The thickness of lingual bone walls was 0.5-1.5 mm in 79.6% of the sites. However, thickness of 2 mm or greater was found in 20.5%. The authors concluded that a thickness of 2 mm resulted in greater stability of the alveolar bone during the process of resorption after extraction.[11]

Immediate placement of implants in extraction sockets was first performed over three decades ago and was prescribed in a consensus issued in 2004 about clinical recommendations and procedures for implant placement in extraction sockets. Several advantages were described: reduction in the number of surgeries; bone availability for implant insertion; and reduction in total treatment time. Some disadvantages, however, have also been

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reported, namely: the fact that the morphology of the site may hinder implant positioning in the arch. Also, it is difficult to achieve primary stability or anchorage, as the procedure is sensitive to the type of technique adopted.[12]

Immediate implant placement does not prevent dimensional changes in the alveolar ridge after tooth extraction. When placed to preserve the dimension of the hard tissue of the ridge after tooth extraction, it results in physiological resorption of the buccal and lingual bone walls, with the dimensions of the buccal bone wall playing a very important role in esthetics.[13]

Tooth shape, size and inclination determine the shape of the alveolar process. This means that the shape and form of the socket and its bone walls vary substantially. This should be taken into consideration whenever immediate implant placement is planned. The thinner the bone wall at a certain site and the closer to this wall the implant is placed, the greater the risk of bone dehiscence.

Implant placement at the time of extraction of a mandibular molar should never be attempted when it is not clear whether it is possible to use an implant of the ideal size and to position it appropriately to achieve primary stability.

According to some authors, the inter-radicular bone should not have a mesiodistal dimension of less than 3 mm to ensure that the mesial and distal faces of the inter-radicular septum are not lost during preparation of the site.[14] Conical implants are often used in this technique to fill the space between the implant and the bone wall. Recent evidence shows that cylindrical, conical or conventional implants have clinically equivalent results in the short term after immediate implant placement.[15] However, the narrow space between the implant and the socket wall cannot prevent bone loss resulting from tooth extraction. The surface of large implants may expose the mucosa during healing, which might compromise treatment results.

Immediate implant placement is associated with the formation of a gap between the implant platform and residual bone walls, and the use of membranes and graft materials has been suggested to address this problem. The use of regenerative procedures aims at preventing the migration of cells from the connective and epithelial tissue in the gap between the implant surface and the walls of the surrounding bone, which would favor the production of osteogenic cells in the process of bone healing.[12] The decision to use these material depends on the size of the residual bone defect. However, the use of Bio-Oss collagen in the cavity immediately after extraction serves as a support to shape tissues, and the ridge profile is better preserved at the sites that receive filling or grafting. The amount of Bio-Oss resorption is very limited by the action of osteoclasts and the resorption of exogenous material.[16] Gap filling with biomaterial after extraction may affect shape and decrease the contraction of the buccal marginal bone crest, thus preserving the socket walls.[17]

## Final considerations

Immediate implant placement is a highly predictable treatment option with considerable success rates, but special care should be taken when indicating this treatment. Tooth extraction should use minimally traumatic techniques; flaps should be avoided; and possible gaps should be filled with biomaterial whenever possible. Immediate implant placement in the region of mandibular molars should have more than 3 mm of inter-radicular bone so as to facilitate implant positioning. The anatomical shape of this region is a challenge to clinicians, who should always seek good primary stability and parameters within the acceptable limits, as reported in this study.

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# Immediate loading on reconstructed maxilla with alogenous bone by means of guided surgery: A case report

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Wilson **ANDRIANI JÚNIOR****
José Nilo de Oliveira **FREIRE*****

**Abstract**

**Introduction:** Implant placement by means of virtual planning and guided surgery can facilitate and optimize surgery, increasing predictability of final outcomes in areas with severe bone resorption. **Objective:** To report a case of guided surgery employed for immediate implant placement in edentulous maxilla previously reconstructed with allograft. **Methods:** Proper care and major advantages of the technique were discussed.

**Keywords:** Dental implant. Allograft. Guided surgery. Immediate loading.

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

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## Introduction

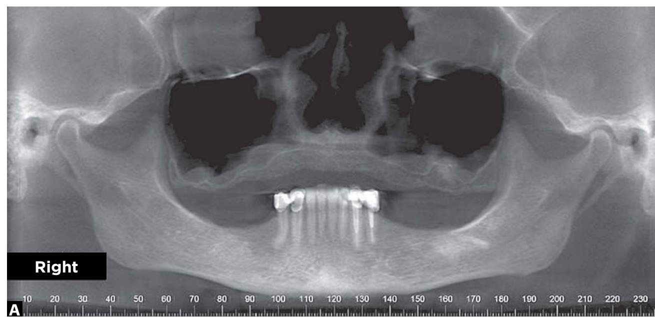
According to data provided by the Brazilian Ministry of Health,[1] the prevalence of denture wearers in Brazil is of 63% among patients aged between 65 and 74 years old, with an average need for implant of 17% in at least one of the arches. The high rates of edentulism are a challenge for Dentistry, given that rehabilitation of esthetics and function of edentulous patients increases their self-esteem and improves their quality of life.[2]

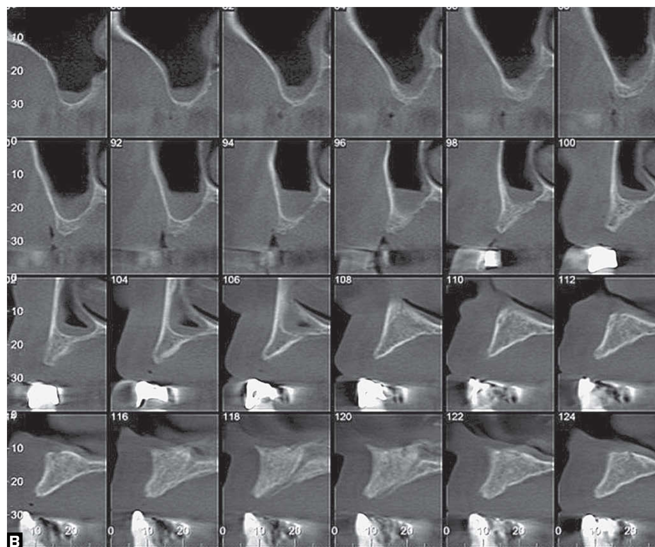
Different techniques have been developed for the total rehabilitation of edentulous patients through Implantology and Prosthodontics. Implant placement through guided surgery is made feasible by computed tomography (CT) scans and prototypes as well as pre-planned surgical guides. For this reason, it facilitates and optimizes surgery and, as a result, increases the predictability of final outcomes. However, edentulism is often associated with severe bone resorption, and demands proper planning that includes reconstruction of large areas of the arches prior to implant and prosthesis placement.

This paper aims at reporting a case of guided surgery used for immediate implant placement in edentulous maxilla with severe bone resorption, previously reconstructed with allograft.

## Case report

The patient was 59 year old, female, with chief complaint of little stability of complete upper prosthesis. After anamnesis, physical and clinical examination, as well as preliminary X-ray scrutiny, a cone-beam CT scan was requested and revealed severe maxillary bone resorption (Fig 1).



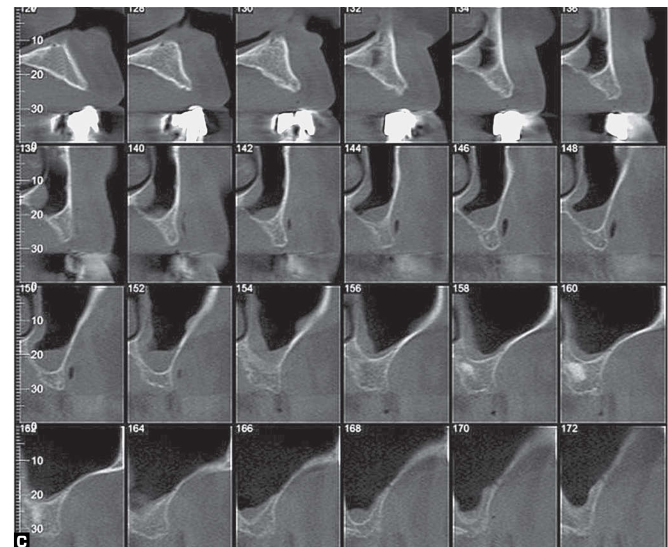




**Figure 1** - Cone-beam CT- panoramic (**A**) and transverse (**B, C**) slices.

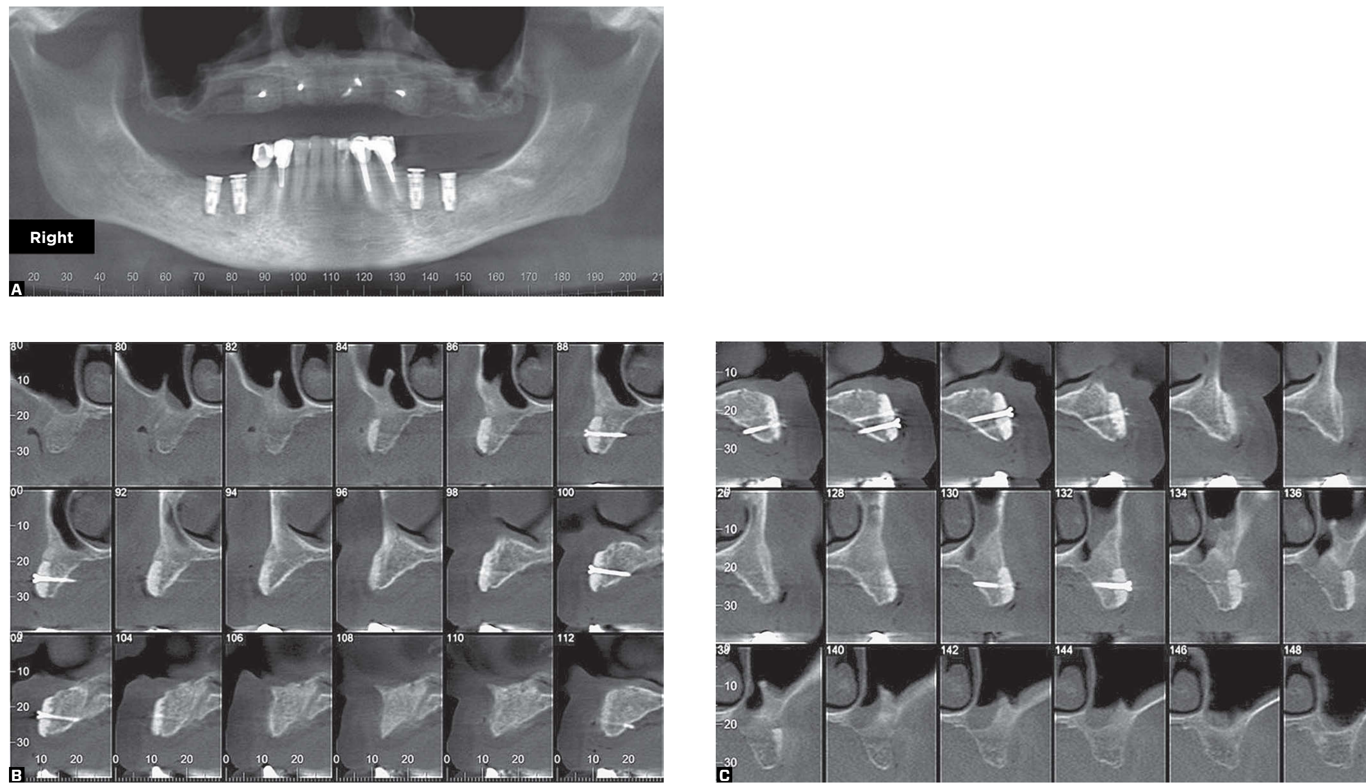



**Figure 2** - Cone-beam CT - panoramic (**A**) and transverse (**B, C**) slices six months after the surgical reconstruction of the maxilla with allograft bone blocks.

After CT scan analysis, block bone grafting was performed to reconstruct patient's maxilla. Implant placement was carried out after six months. Further planning included placement of an upper immediate denture through computer-guided surgical technique.

The patient was non-smoker and did not make routine use of medication. The clinical examination revealed that the prosthesis was well placed, despite little stability. She had healthy gingival and mucosal tissue. Complete blood count, coagulation and blood glucose tests revealed no alterations. Oral antimicrobial and non-steroidal anti-inflammatory drugs were prescribed during the preoperative phase.

Bone grafting was performed in the operating room at the Brazilian Association of Dental Surgeons / Florianópolis, under local anesthesia with intravenous sedation, supervised by an anesthesiologist. Four blocks of allograft bone from a bone bank (UNIOSS, Marília, São Paulo, Brazil) were used and fixed with bone graft screws.

A new cone-beam CT scan was taken six months after surgery and revealed proper integration of the blocks to the remaining jawbone (Fig 2).

To proceed with immediate loading plan treatment, a virtual surgical planning was performed using the Dental Slice software (Bioparts, Brasília, Brazil) with subsequent preparation of the prototyped guide (Fig 3) for two different purposes: to function as a surgery guide and as a base for immediate implant-supported denture construction (Fig 4).

Guided surgery was performed as planned after the dental prosthesis was manufactured. All preoperative procedures were performed, including prescription of oral antimicrobial and anti-inflammatory drugs.

After infiltrative administration of local anesthesia, the vertical dimension of occlusion was recorded in centric relation with the surgical guide within the patient's mouth (Fig 5) so as to guide the subsequent placement of immediate full denture.

The fixing screws of the alogenous bone blocks were placed, and small incisions were made for their removal (Fig 6).

Subsequently, three fastening screws 2 mm in diameter and 8 mm in length were installed to guide stabilization: one in the anterior region and two in the premolar region (Fig 7). Implant placement sites were opened with a rotational circular scalpel at 80 rpm. Surgical instrumentation was performed by observing the progressive sequence of cutters, according to the surgical protocol, until it reached a diameter of 3.3 mm (Fig 8).

Internal-hexagon implants 3.75 mm in diameter and 15 mm in length were used in the cuspid area, whereas implants 3.75 mm in diameter and 13 mm in length were installed in the region of lateral incisors and second premolars (Fig 9).

The surgical guide was removed and the prosthetic components (microunits) were placed, five angled at 17° and one straight (tooth #25) (Fig 10). They were previously selected during the virtual planning and used to construct the prosthesis.

The pre-made full denture was installed with the use of temporary metal copings embedded in acrylic resin (Fig 11).

## Discussion

Proper treatment planning relies on satisfactory diagnosis. Patient's detailed clinical and physical examination is essential. Volumetric computed tomography, study models and surgical guides are imperative, given that enable correct positioning of implants and a better distribution of mechanical forces.[3]

In the case reported herein, the areas with severe maxillary bone resorption were reconstructed with allograft. Autogenous bone is the first choice of treatment for reconstruction of severe alveolar bone defect.

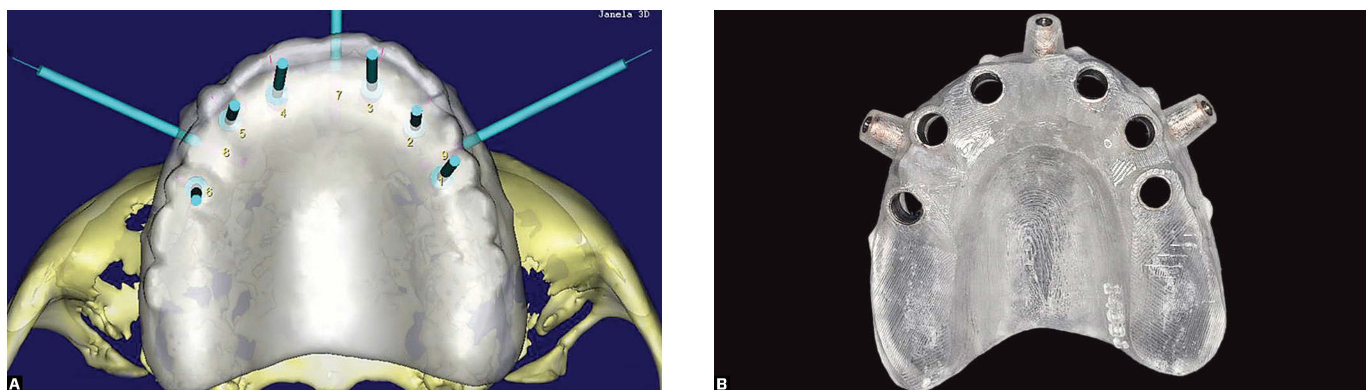



**Figure 3** - Planning in a virtual environment. Note the axial positioning of implants in relation to the final prosthesis – 3D image of the Dental Slice software (Bioparts, Brasília, Brazil) (**A**) and prototype (**B**).

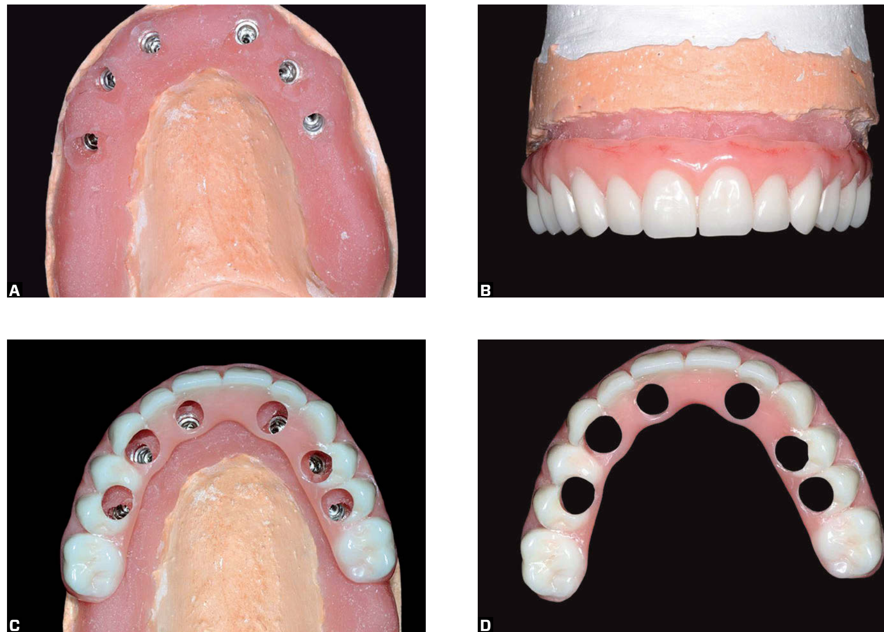


**Figure 4** - Analog working models (**A**) and total prosthesis (**B**, **C** and **D**).

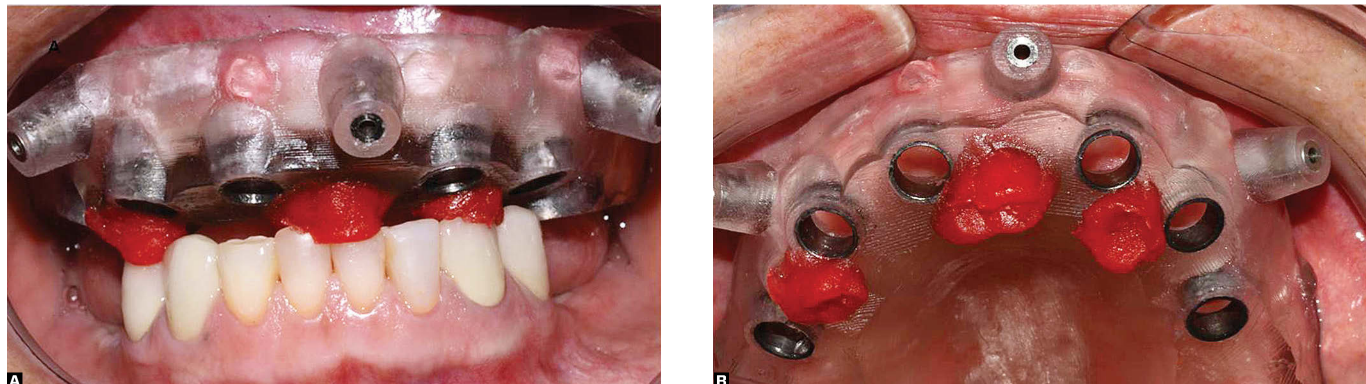


**Figure 5** - Clinical vestibular (**A**) and occlusal view (**B**) of the prototyped guide in the mouth after bite registration in centric relation.

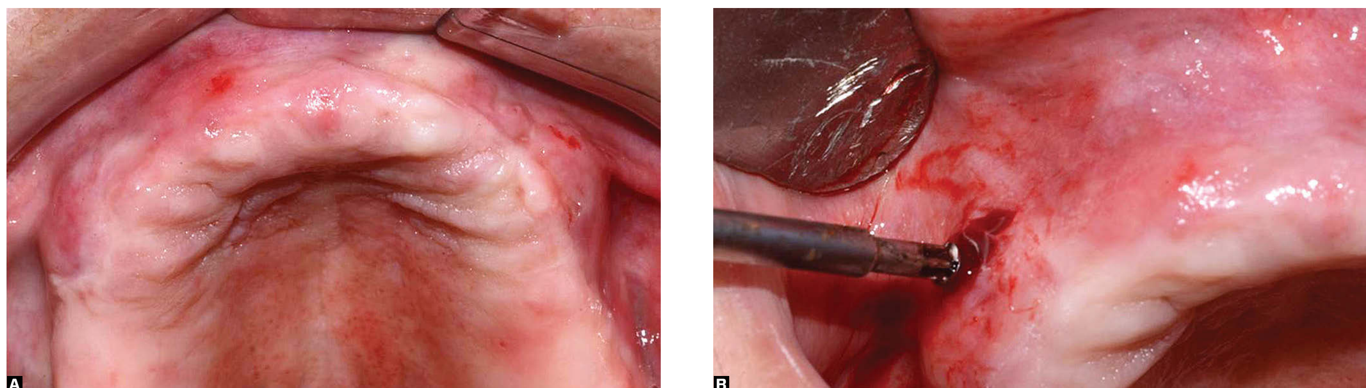
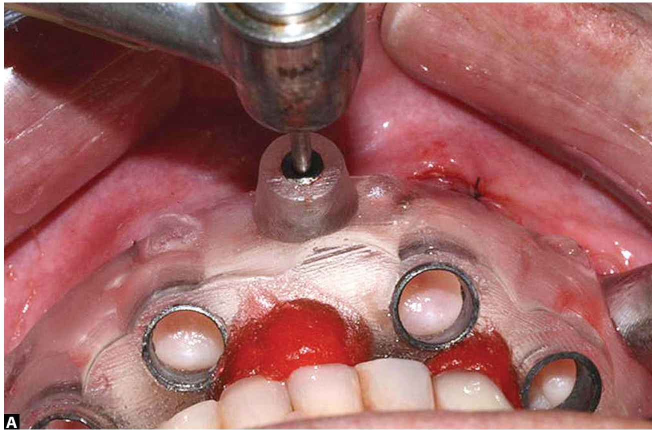


**Figure 6** - Overview of the reconstructed maxilla (**A**) and incision to remove the fastening screws of the allograft bone blocks (**B**).



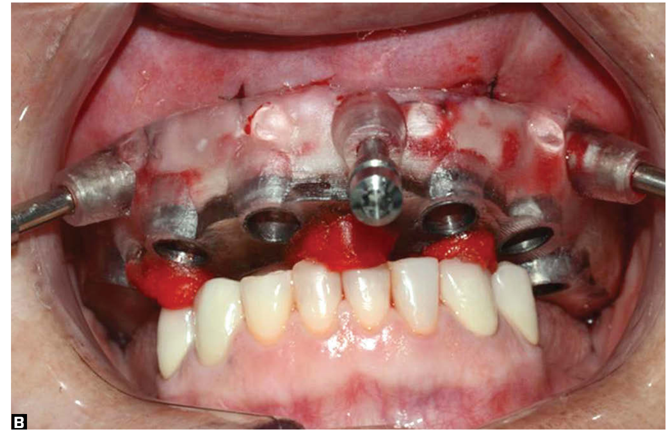
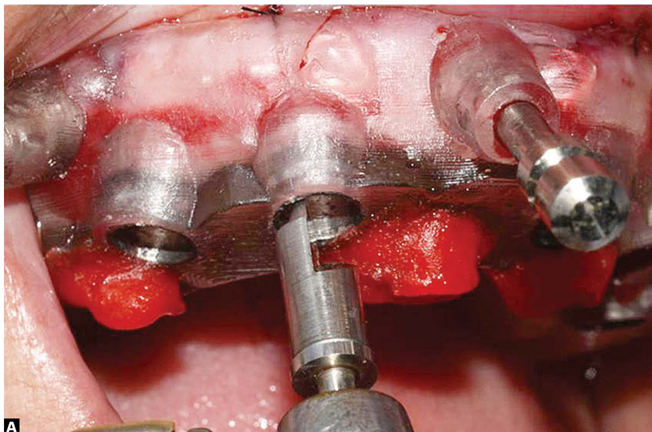


**Figure 7** - Fastening screws installation (**A**). Guide stabilization with three fastening screws (**B**).



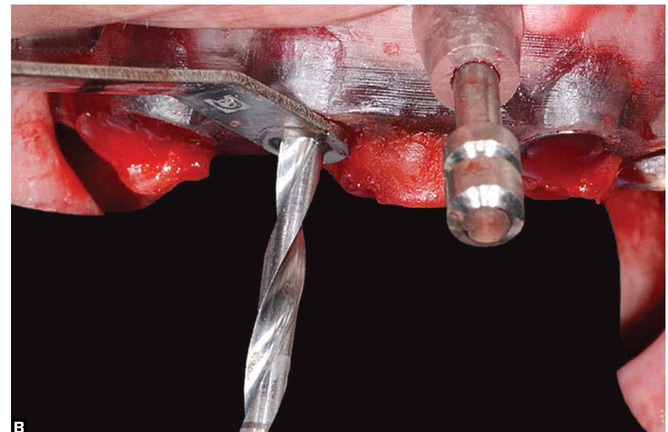
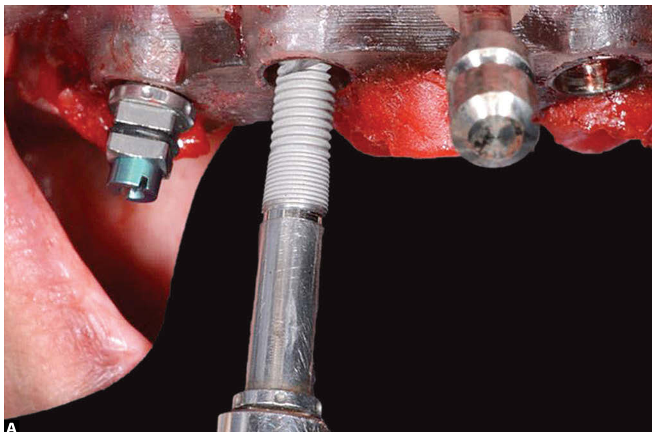


**Figure 8** - Opening with a rotational circular scalpel (**A**) and sequence of cutters (**B**).



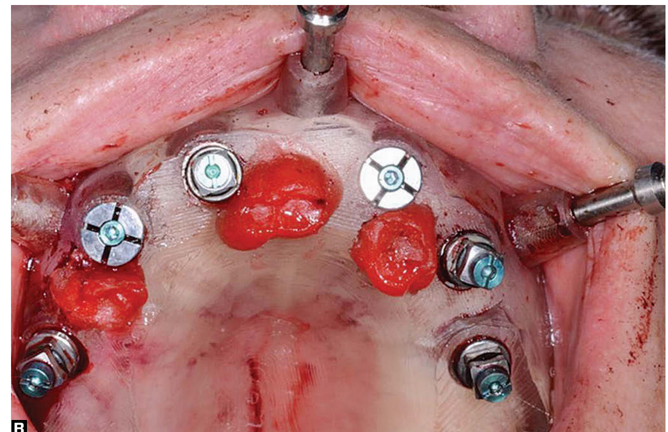


**Figure 9** - Implant placement (**A**). Installed implants (**B**).

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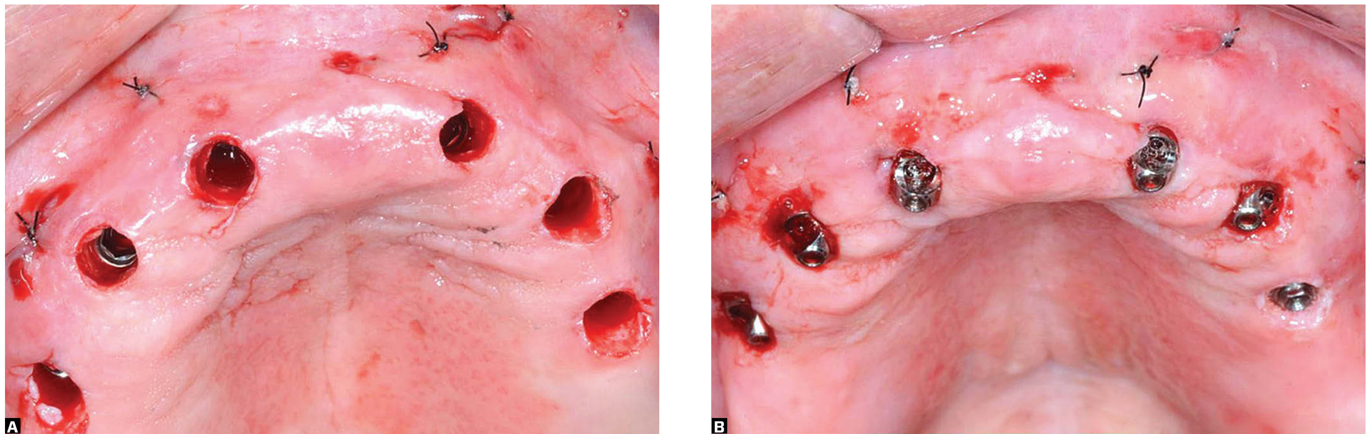


**Figure 10** - Installed implants with the guide removed (**A**). Installed prosthetic components (**B**).

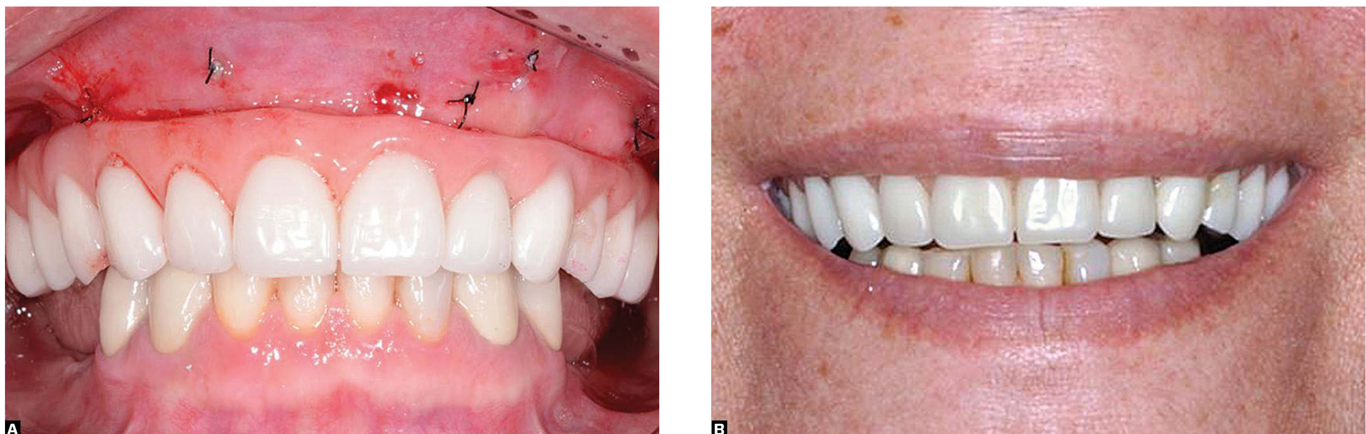


**Figure 11** - Prosthesis installed right after surgery (**A**) and 20 days after surgery (**B**).

It results in more predictable outcomes, prevents disease transmission and offers full histocompatibility.[4] However, the need for a second bone harvesting site has increased the interest in procedures that reduce the consequences inherent to the donor area. In this context, allograft bone obtained from a donor is considered a feasible alternative. With the emergence of tissue banks and the expansion and improvements in preservation techniques, there is increased availability of allograft bone tissue, which constitutes an important aid for severe bone resorption cases.[5]

The advantages of using allograft bone include increased availability of tissue and elimination of harvesting surgical sites, with consequent prevention of morbidity in the donor site and possible reduction in treatment costs.[6] As for disadvantages, they include the risk of disease transmission and potential antigenicity, which are complications that can be controlled by processing methods. The risk of infection can be reduced by serological testing of donors, dispose of material that produces positive bacteriological culture, and manipulation of bone graft under aseptic and sterilization conditions.[7]

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A limited number os studies has focused on alveolar ridge reconstruction with allograft bone. In a bibliographic review, Levandowski et al[5] showed that the clinical results are satisfactory, but the literature does not show sufficient methodological quality to justify the use of allograft bone when autogenous bone is available. Even so, the authors concluded that bone allograft undergoes biological changes that are qualitatively similar to autogenous bone grafts, but they occur more slowly. Moreover, they showed that the time for bone allograft incorporation and remodeling can take from 40 to 90 days for small grafts and can be indeterminate for large grafts.

On the other hand, cone beam computed tomography images processed in computer software enable virtual surgical planning, making it possible to visualize, three-dimensionally, the relationship between implants and arch anatomy.[8] When associated with stereolithography, CBCT images enable prototyping and the fabrication of surgical guides through computational modeling. The use of prototypes accurately reproduces the anatomy of the area to be rehabilitated, thus facilitating the surgical technique and anticipating problems and solutions with more predictable results.[9]

Associating a surgical guide used for diagnosis with implant placement is highly advantageous and improves final results.[10] The guide provides accurate information not only about the buccolingual inclination of the planned implant, but also about bone size and anatomical features.[11] Because the surgical planning is computerized in three dimensions, implants can be placed in the exact position, based on the bone structure.

Once treatment plan is established, the surgical guide is made of acrylic, with metal cylinders attached to implant analogs to create a prosthetic model. The cylinders also function as guide points for milling during implant bed preparation, which allows correct position and inclination. Additionally, the diameter of the guides corresponds to the diameter of the cutters, which leads to a smaller margin of error.[12] The guide is placed in the oral rehabilitation area by means of screw fasteners, allowing surgical stability.

Prototype models have the advantage of providing comfort to the patient during the surgical procedure. This is made possible through virtual guided surgery. The prototyping technique enables guided surgery and optimal implant placement based on the prosthetic planning that results in the immediate installation of a provisional implant-supported prosthesis in the maxilla or mandible[9]. Guided surgery requires minor incisions, providing greater comfort to patients with less postoperative pain and swelling.[3]

Immediate implant loading is highly advantageous for rehabilitation of edentulous cases. Placement of implants and total prosthesis in one single session is another advantage. In addition to improving patient's self-esteem,[2] the procedure allows patients to return to their daily activities within a short period of time as a result of esthetic and functional recovery. Furthermore, it reduces healing time, given that no major manipulation procedures of mucosa and periosteum are performed, thus favoring osseointegration.[13-17] Nevertheless, primary implant stabilization is required, and it is related to implant geometry, bone anatomy and surgical technique.[9]

According to Holcman et al,[3] the success rates of immediate implant placement are similar to those of delayed loading after osseointegration. For this reason, and due to treatment predictability, these authors recommend the use of a single-session surgical protocol with the application of immediate load, which simplifies rehabilitation without compromising functional and esthetic results.

## Conclusion

The implant method described above proves to be highly advantageous for yielding immediate function and esthetic results. The single-stage surgical protocol and flapless surgical procedure provide greater comfort for the patient during surgery, as well as a more favorable postoperative period. The use of allograft bone blocks enable high-quality bone structures to receive the implant. This was evidenced by the good primary implant stability achieved. Furthermore, the technique had the advantage of avoiding harvesting of autogenous bone graft, which resulted in lower morbidity risks and consequent increased pre- and post-surgical comfort.

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

Dario Augusto Oliveira **MIRANDA***

## The epidemiology of peri-implantitis

**Mombelli A, Müller N, Cionca N**. *Clin Oral Implants Res. 2012 Oct;23 Suppl 6:67-76.*

**Aim:** To review the literature on the prevalence and incidence of peri-implantitis. **Methods:** Out of 322 potentially relevant publications we identified 29 articles concerning 23 studies, with information on the presence of signs of peri-implantitis in populations of at least 20 cases. **Results and Conclusions:** All studies provided data from convenience samples, typically from patients who were treated in a clinical center during a certain period, and most data were cross-sectional or collected retrospectively. Based on the reviewed papers one may state that the prevalence of peri-implantitis seems to be in the order of 10% implants and 20% patients during 5-10 years after implant placement but the individual reported figures are rather variable, not easily comparable and not suitable for meta-analysis. Factors that should be considered to affect prevalence figures are the disease definition, the differential diagnosis, the chosen thresholds for probing depths and bone loss, differences in treatment methods and aftercare of patients, and dissimilarities in the composition of study populations. Smoking and a history of periodontitis have been associated with a higher prevalence of peri-implantitis.

## A comparison between endodontics and implantology: an 8-year retrospective study

**Vozza I , Barone A , Quaranta M , Paolis G , Covani U , Quaranta A**.
*Clin Implant Dent Relat Res. 2013 Feb;15(1):29-36.*

**Aim:** The aim of this study was to compare endodontic and implant treatments and to evaluate their predictability over an 8-year period on the basis of an analysis of survival data and a retrospective clinical study. **Material and Methods:** A group of 40 partially edentulous patients were selected for this study. Their teeth had been endodontically treated and rehabilitated using gold alloy and ceramic restorations. In these patients, 65 osseointegrated implants were restored with single gold alloy-ceramic crowns and monitored on a yearly basis for 8 years with standardized periapical radiographs, using a polivynilsiloxane occlusal key as a positioner. A total of nine patients who did not attend the yearly follow-up were excluded from the study. The Melloning and Triplett criteria were used to evaluate the clinical results obtained in the implant sites. The clinical results of the 56 endodontically treated teeth, restored with the fixed prosthesis of 40 patients, were analyzed according to probing depth as well as an assessment of the correct apical and coronal seals. The survival rate was calculated using the Kaplan-Meier method and the statistical significance was calculated using the chi-square test. **Results:** During the follow-up of the

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endodontically treated elements, seven failures were detected (83.34%) and the success rate of implants inserted in the same patients was equal to 80.8%, with nine implants lost in 8 years. The survival analysis of the elements treated with both therapies was not statistically significant (p = 0.757) and the confidence interval was between 0.2455 and 2.777. **Conclusion:** In view of the superimposable results between the two therapies, it should be noted that the endodontically treated teeth could be interested by different pathologies while the restoration of the atrophic edentulous ridge with an implant support is predictable when patients comply with correct oral hygiene and when the occlusal loads are axially distributed in implant-protected occlusion.

## Effectiveness of a mouthrinse containing active ingredients in addition to chlorhexidine and triclosan compared with chlorhexidine and triclosan rinses on plaque, gingivitis, supragingival calculus and extrinsic staining

**Kumar S, Patel S, Tadakamadla J, Tibdewal H, Duraiswamy P, Kulkarni S**. *Int J Dent Hyg. 2013 Feb;11(1):35-40.*

**Aim:** To assess the effectiveness of three different mouthrinses — chlorhexidine, triclosan + sodium fluoride and chlorhexidine + triclosan + sodium fluoride + zinc chloride — on plaque, calculus, gingivitis and stains and to evaluate the occurrence of adverse effects with these three treatments. **Methods:** Forty-eight healthy subjects participated in a double-blind, randomized, parallel experiment and were randomly allocated to any one of the three experimental mouthrinses: group A (0.2% chlorhexidine (CHX) gluconate), group B (0.03% triclosan + 0.025% sodium fluoride (NaF) + 12% ethyl alcohol) or group C (0.2% CHX + 0.3% triclosan + 0.3% NaF + 0.09% Zn chloride (ZnCl(2)). All the subjects were assessed for gingivitis, plaque, supragingival calculus and extrinsic stains at baseline and at the end of the 21-day experimental period. **Results:** There was a significant difference (P = 0.046) in the effectiveness for the prevention of gingivitis and plaque, with subjects of group A and group C presenting least and highest gingival and plaque scores, respectively. Significant differences (P = 0.03) were observed for the accumulation of supragingival calculus where the deposition of calculus in group A was nearly double that of the group B, and group B was most effective in the prevention of supragingival calculus. Highest deposition of extrinsic stains was in the group A followed by group C and group B. There was no significant difference between the three treatments for adverse events' occurrence. **Conclusions:** CHX mouthrinse was most effective in controlling plaque and gingivitis but caused greatest deposition of extrinsic stains. Supragingival calculus deposition was least in triclosan + NaF group followed by CHX + triclosan + NaF + ZnCl(2) and CHX. More than half of the subjects reported adverse events during the experimental phase.

## Search strategies in systematic reviews in periodontology and implant dentistry

**Faggion CM Jr, Atieh MA, Park S**. *J Clin Periodontol. 2013 Sep;40(9):883-8.*

**Aim:** To perform an overview of literature search strategies in systematic reviews (SRs) published in periodontology and implant dentistry. **Material and Methods:** Two electronic databases (PubMed and Cochrane Database of SRs) were searched, independently and in duplicate, for SRs with meta-analyses on interventions, with the last search performed on 11 November 2012. Manual searches of the reference lists of included SRs and 10 specialty dental journals were conducted. Methodological issues of the search strategies of included SRs were assessed with Cochrane collaboration guidelines and AMSTAR recommendations. The search strategies employed in Cochrane and paper-based SRs were compared. **Results:** A total of 146 SRs with meta-analyses were included, including 19 Cochrane and 127 paper-based SRs. Some issues, such as "the use of keywords," were reported in most of the SRs (86%). Other

issues, such as "search of grey literature" and "language restriction," were not fully reported (34% and 50% respectively). The quality of search strategy reporting in Cochrane SRs was better than that of paper-based SRs for seven of the eight criteria assessed. **Conclusion:** There is room for improving the quality of reporting of search strategies in SRs in periodontology and implant dentistry, particularly in SRs published in paper-based journals.

## Rehabilitation of deficient alveolar ridges using titanium grids before and simultaneously with implant placement: a systematic review

**Ricci L, Perrotti V, Ravera L, Scarano A, Piattelli A, Iezzi G**. *J Periodontol. 2013 Sep;84(9):1234-42.*

**Aim:** The aim of the present study is to perform a systematic review of the literature on the use of titanium grids for implant surgery before and simultaneously with implant placement and to assess the success rate of the procedure, as well as survival and success rates of implants placed in the regenerated areas. **Methods:** Medline was used to identify studies in English published from 1996 to 2011. An additional hand search was performed of the relevant journals and of the bibliographies of the papers identified. Articles retrieved by two independent authors were screened using specific inclusion criteria: randomized controlled trials (RCTs), controlled clinical trials, and prospective clinical studies regarding vertical and/or horizontal regeneration of the alveolar ridge using titanium grids, in association or not with biomaterials, before and simultaneously with implant placement. **Results:** Six articles were selected, including a total of 79 patients, 87 titanium grids, and 141 implants. Twenty-four implants were placed simultaneously with titanium grids, and 117 implants were inserted after a period of 4 to 9 months. Titanium grids in combination with autogenous bone were used in 43 cases, 25 in combination with a mixture of autogenous bone and bone substitutes, 14 in association with bone substitutes, five using only titanium grids. The overall success rate of the regenerative procedures was 98.86%; the overall survival and success rates of implants were 100% and 93.2%, respectively. **Conclusions:** The main limit of the present systematic review is the scarcity of papers with an adequate and consistent methodology regarding the data collection and analysis and the lack of RCTs and large well-designed long-term trials. Survival and success rates of implants placed in the areas treated with titanium grids were comparable to those of implants placed in native, non-regenerated bone and of implants placed in bone regenerated with resorbable and non-resorbable membranes.

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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**

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