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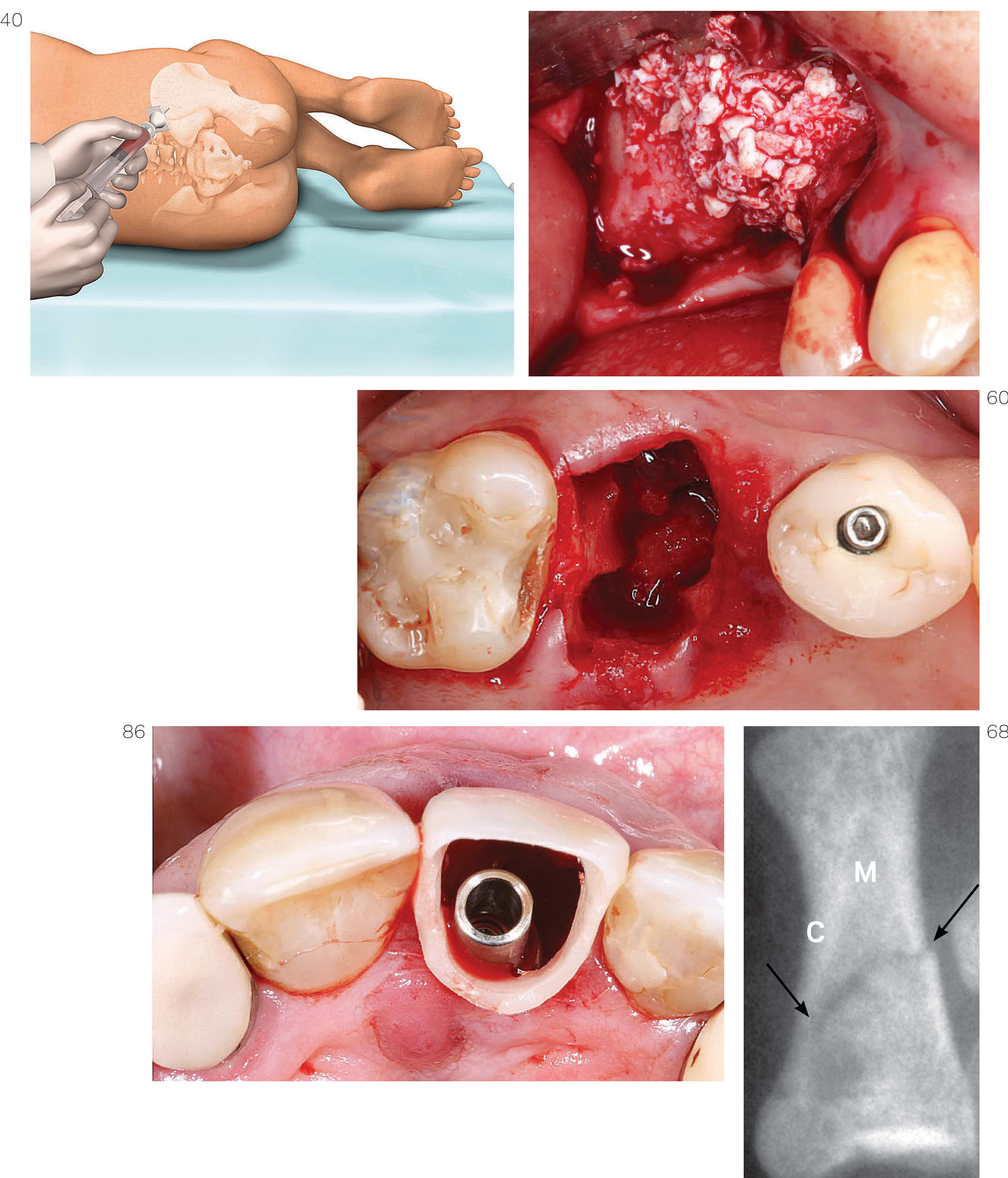
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The responsibility of a major challenge

Waldemar D. Polido
Editor-in-chief

With feelings of deep excitement and major responsibility, I step forward as the head of a journal that plays a major role in Brazilian Dentistry: **Dental Press Implantology**.

A journal that had as editors-in-chief some of the icons of Brazilian and international Dentistry, such as Prof. Dr. Carlos Eduardo Francischone and Dr. Maurício Araújo, lays responsibilities of massive proportions.

I took my first steps in Implantodontics in 1991, when I entered into the Master's program of Oral and Maxillofacial Surgery after my residency in the USA. Since then, I have had Dr. Laércio Vasconcelos and Prof. Dr. Carlos Eduardo Francischone's support. They opened me the doors to Implantology and let me work side by side with Prof. P-I Brånemark, the founder of osseointegration and with whom I had the golden opportunity to have a close relationship as a friend and as a learner. Prof. Francischone has always stimulated research, science and scientific evidence — areas in which I have great interest. These areas are part of my daily routine and, undoubtedly, have contributed to raise personal as well as professional affinity, which allowed me to be remembered for the position I occupy at present.

Prof. Francischone's participation as an emeritus editor is key to Dental Press Implantology success. He works in partnership with another emeritus editor, my friend and colleague Maurício Araújo, an internationally renowned professor and researcher who, without a doubt, is the most noticeable name in Brazilian as well as international Dentistry nowadays. His publications are significantly cited as reference in modern Implantodontics, and have changed the way we treat our patients. I have had the opportunity to have a close relationship with Dr. Maurício, learning and admiring one

of the most requested speakers around the world. I am sure that, as an emeritus editor, he will also devote some of his time, knowledge and experience to help us strength **Dental Press Implantology**.

Ever since its first issue, Implantology has excelled at high-quality design, modern layout and easy flow. The invitation made by Prof. Dr. Laurindo Furquim (Dental Press publisher), and the opportunity to work with a family, but extremely competent and professional company, were major stimuli that encouraged me to accept the position. I hope to meet all the trust Dr. Laurindo and his team have placed on me, and I promise to work hard and devote myself to meet the expectations of the invitation!

This new challenge brings along change and renewal. I deeply thank the editorial board of this journal and hope they keep on contributing and submitting papers. Nevertheless, we recognize the need to "oxygenate" the group by incorporating other colleagues not only from Brazil, but from all around the world, all of which will certainly share their experiences and contribute to increase the quality of Implantology. I henceforth thank the new associate editors and editorial consultants for their eagerness and immediate response to my invitation.

The first issue of 2014 remains similar to previous issues. However, significant changes will be implemented from the second issue on, with new sections, new assistant editors, stronger international contribution and new layout.

I deeply thank all the trust on me placed and I hope you keep on enjoying **Dental Press Implantology**!

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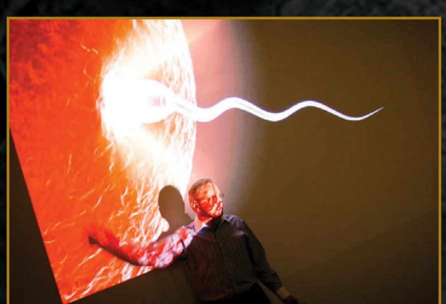

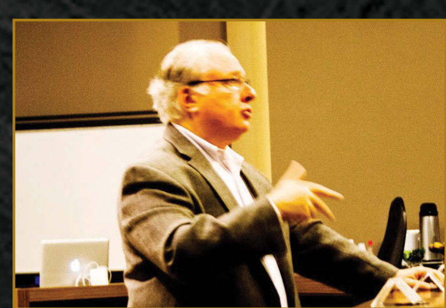

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José Carlos Martins da Rosa

The interviewee of this issue is a highly respected professional of excellent reputation in modern Brazilian Dentistry.

He graduated from the Federal University of Santa Maria/RS (UFSM) in 1988; received his specialist degree from the Association of Dental Surgeons/Bauru - São Paulo (APCD) in 1991; and his specialist and Masters degree in Prosthesis from the Dental Research Center São Leopoldo Mandic/Campinas – São Paulo in 2005. At present, he is a PhD resident in Implantodontics also at São Leopoldo Mandic.

Our interviewee is the author of "Restauração dentoalveolar imediada — Implantes com carga imediata em alvéolos comprometidos" (Immediate dentoalveolar restoration - Immediately loaded implants in compromised sockets) issued by Ed. Santos in 2010. His book has also got a Spanish (2012) and an English version (2014). Furthermore, he has several articles published in outstanding national and international journals.

José Carlos Martins Rosa is from São Vicente do Sul, a little town located in the countryside of Rio Grande do Sul. He is married to Ariádene Cristina Pértile Rosa who is also a dentist, his partner and contributor. According to Dr. Rosa, she is the active and essential author of the happiest moments of his professional and personal life. His wife is his balance.

His family and friends are responsible for a considerable portion of his emotional master pillar. For him, they are indispensable in his decision-making processes, as they always encourage him to move towards the correct direction.

Thus, Dental Press Implantology brings to the reader the outstanding profile of a young, competent talent of Brazilian Dentistry who also stands out for his polished civility and diplomatic genteelness not only in day-to-day social life, but also with those who are around him. Dr .Rosa is a strict professor and sensitive researcher. Methodical and organized, he is able to selectively identify and associate the skills that effectively contribute to add and multiply potential results.

He is the owner of an avant-garde dental center equipped with modern facilities strategically associated with important hospital resources planned with a view to working with excellence, biosafety and high technology. His clinic also has a center for professional enhancement and qualification consisting of an auditorium with integrated clinics for events, immersion courses, as well as study and research groups. Renowned professionals from all around the world have taught courses and given workshops at the dental center owned by Prof. Rosa.

In this interview, José Carlos Martins Rosa talks about the administrative vision and management model employed at the dental center he founded. Furthermore, he helps us understand the IDR protocol, a technique he strongly advocates.

He also talks about family, his greatest influences, the professors who inspired him, his publications, courses, and future plans. This interview is an interesting, productive and illustrated journey across human and scientific values that directly display the pathways of good example, simplicity, interest in research and deep love for everything that is done.

While talking about his plans for the future, Prof. Rosa mentions:

"...I intend to develop other projects inside and outside the field of Dentistry, activities that will contribute to our growth as human beings, helping people in need or difficulties. I intend to spend more time with my family, to be more present by giving and valuing the simplest things. I believe this is the essence of life. Life! God has bestowed on me so many good things! It is high time I gave it back...".

We are certain that such gratitude is partially achieved by the generous sharing of information provided in the following pages.

Franklin Moreira Leahy

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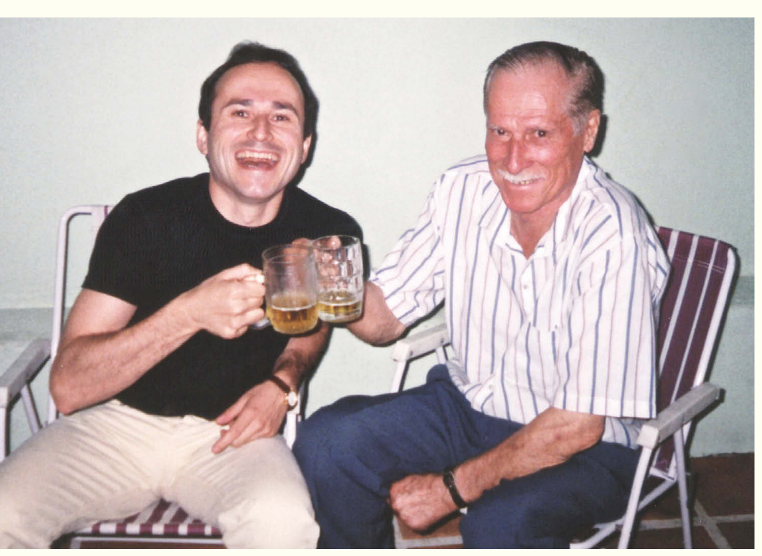
How and when did you become interested in Dentistry?

I come from São Vicente do Sul, a little and calm town in the countryside of Rio Grande do Sul where I lived until the age of ten. My parents, Darcy and Maria, decided to move to Santa Maria so that their eight children could go to school. I was the youngest, and was privileged to have Luiza, Arlei, Helena, Marlene, Milton, Jane and Darcymar as my siblings who broke down the barriers and opened the way for me. Our parents were indefatigable and always encouraged us to study, as they believed this was the only way to achieve a better future. They went through times of difficulty to have their dream of seeing their children graduated from a university come true.

I have three siblings who are odontologists: Luiza, Arlei and Darcymar. And they are the reason of my professional choice. My passion for Dentistry arose before I entered the Federal University of Santa Maria, as I helped my siblings at their clinic. Before university, I had the opportunity to understand the functional, esthetic and psychological benefits of Dentistry. My family always supported me and were determining as I followed that road with success. Dentistry became my career and the reason behind my personal satisfaction.



With his father, Darcy Pilar da Rosa, at an informal gathering.

In Caxias do Sul, you founded a modern private dental center named after you. It was developed with a highly respected infrastructure that meets the present technological, ergonomic and biosafety requirements. Could you tell us about the history and planning of such task until it reached its current quality and excellence status?

At a given point of my career, in the 90s, I was presented to the universe of teaching. I taught a few courses on the specialties I work with (Periodontology, Prosthesis and Implantodontics) and coordinated specialization programs in Implantodontics in the 2000s. Passing on what we learn is very gratifying. Having a building where I could put this project into practice with autonomy had always been a dream.

Furthermore, since I worked at much smaller premises, I depended on a hospital where I could carry out more complicated surgical procedures. I had always wished for a building that offered safety and comfort during such procedures. Should it allow us to practice all dental specialties, including a prosthesis lab with which we could speed up prosthetic cases, my dream would be fulfilled.

That was when, in 2001, my wife Ariádene and I decided to invest in a dental center which we opened in 2006. During the last few years, we were privileged to have a multidisciplinary group in which Marcos Alexandre Fadanelli, our colleague and

friend, is a key figure. In addition to acting in the clinical practice, he also helps my brother Darcymar Martins da Rosa to develop the courses we offer. Together, we receive students from all around the world. We also have the opportunity to welcome nationally and internationally renowned professionals who teach at our courses and with whom we have partnered at several publications. We have given courses to Spanish-speaking students, and our next goal is to teach English-speaking students. It certainly is a very demanding, but rewarding task.

Good management, organizational and methodological skills combined with a creative and competent management model are key to success. As a highly respected professional within the Dentistry field, what are your main concerns and recommendations?

Running a business is always challenging, and a dental business is not different. We work; above all, with the promotion of health and, for this reason, we have to know how to deal with patient's pain, whether physical or psychological. Cosmetic Dentistry — highly valued nowadays — adds the challenge of dealing with patient's expectations which sometimes are unattainable. Managing expenses and people is a daunting challenge, especially when the goal is to provide them with high-quality treatment that yields excellent esthetic results. Implementing dental care and biosafety protocols as well as carrying out clinical and surgical procedures, all of which are activities related to the organization of a dental center, provide rendering of services that are safe and efficient, and build patient's and employee's trust.

With his mother, Maria Adelina Martins da Rosa, and his seven siblings.

Nevertheless, none of the above is possible without a good and harmonious team. Assembling and keeping a team of people who look at the same direction demands great effort. They need to share the same goals and continuously reinforce their ideals so as to keep everyone motivated and satisfied. Whenever one loses, everybody else does. Whenever one wins, everybody wins. To my view, the human factor is the most important.

Using a very cliché term, we can say that entrepreneurship is part of the professional profile of those who aim at succeeding and prospering in life. Your working facilities include hospital resources that provide patients and professionals with safety, comfort and convenience. Do you believe that your achievements can be considered as benefits and effective advances in Dentistry? What would you highlight as an example of administrative efficiency within the Dentistry field?

The goals of any business, regardless of the field, must be clearly established even

With his three siblings who are odontologists: Arlei, Luiza and Darcymar who strongly influenced his professional choice.

before they are written down on paper. As you have mentioned, counting with a hospital infrastructure is convenient for both professionals and patients, and it certainly is an advance. However, it also requires odontologists to responsibly meet a few requirements and seriously carry out a few protocols they are not used to. The exchange established with physicians and nurses is what makes our work feasible. Such communication must continuously flow.

Our goal has always been very clear: enjoy comfort while performing treatment protocols with responsibility. It is a two-way road. I believe that the contribution I have given to Dentistry as a result of my achievements includes rights and obligations; accommodation and "disaccommodation".

Your interest in studying and disclosing the IDR (immediate dentoalveolar restoration) protocol made you well-known nationally and internationally. It also influenced you to engage in Implantodontics as an eager researcher and author of a book named after the technique. Immediate dentoalveolar restoration (IDR) is considered by many as an extremely important branch of modern Implantodontics due to being easily performed with low morbidity and proven clinical efficiency. For the most enthusiasts, it should certainly comprise the therapeutic arsenal of any up-to-date implant dentist who aims at optimizing rehabilitation results — especially when the clinician chooses to work with osseointegrated implants placed in compromised socket in esthetic zones. In this context and based on your experience, do you believe that the IDR technique is the first treatment option nowadays? Is it able to replace classical techniques such as autograft, GBR, biomaterial or xenografts?

No surgical technique is universally indicated for all cases. Nor can it be considered as good as or worse than others. To my view, all techniques are valid and have advantages as well as disadvantages. Whenever more than one technique is indicated for a given case, the clinician must choose the one he is skilled at performing, the technique that proves feasible to him and which is affordable for the patient.

The IDR, first developed 7 years ago, is a surgical technique used to treat compromised sockets. It combines bone reconstruction and immediate implant placement. Its main advantages are: maintenance of gingival architecture due to being a flapless procedure; reduction in the number of interventions due to being a single procedure; and reduction in final treatment costs, given that it makes use of autograft. The use of autograft harvested from maxillary tuberosity, a structure rich in medullary bone,

enhances treatment results. Provided that it be properly handled, medullary bone has osteoconductive, osteoinductive and osteogenic properties, all of which are desired to optimize bone repair.

Our team has treated more than 300 cases, and has clinically, radiographically and tomographically monitored them with high enthusiasm. Photomicrographic analysis and scanning electron microscopy of repaired bone let us deeply understand the results yielded, not only in terms of quicker bone repair, but also with regard to bone stability over time. Due to the large amount of feasible osteoprogenitor cells found in this type of bone, I dare to say that it is considered as “bone transplant”. To this end, strict criteria for removing it from the donor site and handling as well as inserting it into the receptor site must be accurately met. Proper training on how to employ the technique, as well as any others, allows us to fully benefit from its essential properties. Credits must be given to our Mother Nature.

Today, based on my own and my study group’s experience, as well as on the results produced by other groups, students, colleagues and friends; I assure that the IDR is my first technique of choice, provided that indications and contraindications be respected. Several groups, linked or not to universities, have been conducting researches on the IDR technique, and aim at including it in their therapeutic arsenal as another treatment option available for professionals and patients.

José Carlos, his wife Ariádene and his brother Darcymar with Prof. Waldyr Antonio Janson in Bauru/SP.

We know that to devise, develop and improve a clinical or surgical protocol it is necessary to study, research and develop an acute sense of observation and, above all, strictly, systematically and multicentrically repeat the experiments and their results always based on previous trials and researches. In this context, what were your major influences? Which professors, mentors, authors or researches were your direct sources of theoretical and practical inspiration, and decisevely contributed to give support and scientific credibility to the well-conceived IDR technique?

I have worked in the Dentistry field for more than 25 years. During this period, many professors crossed my path, leaving their footprint, smoothing the rough edges and shaping my course in life. The Federal University of Santa Maria provided me with

During his first lecture on immediate dentoalveolar restoration, in 2007, at the auditorium of the P-I Brånemark Institute (Bauru/SP) delivered at the event organized by Prof. José Scarso Filho.

a good educational basis. Its academic staff counted with Prof. Ney Mugica Mutti, one of my greatest sources of inspiration, a professor who strongly insisted that I entered the postgraduation program in Bauru/SP. In the late 80s, I met Prof. Waldyr Antonio Janson in Bauru. Having him as my professor definitively changed my professional life, not only for his extensive knowledge on Periodontology and Prosthesis, but also for his precious life lessons. Since then, I became his follower and have pursued his example of motivation to continuously go on a quest for knowledge and excellence in clinical results.

In 1991, I became involved with Implantodontics in Caxias do Sul where I was advised by Profs. Luiz Henrique Zaniol and Edemar Locatelli. I also had Prof. Cezar Augusto Garbin's excellent research on rehabilitation as one of my sources of inspiration. During that period, Drs. Darcy Locatelli and Sérgio Abraham were two key figures who strongly encouraged me. After that, between 1990 and 2000, I was deeply influenced by professors who worked with bone surgical reconstruction and soft tissue manipulation: Profs. Deoclécio Nahás, José Scarso Filho and Glécio Vaz de Campos.

Since 2008, I have had the chance to strengthen the bond with Prof. Carlos Eduardo Francischone, a fatigueless professor and full-time supporter. I have always admired and respected his work and, today, it is a pleasure and an honour to have him advising me as I write my PhD dissertation. During my PhD residency, I also had the opportunity to meet Dr. Alberto Consolaro who has expended my knowledge and understanding on several topics, including the IDR technique. Our doctorate programm resulted in a strong research group — initially set up in Bauru and, nowadays, established at São Leopoldo Mandic College in Campinas/SP — consisted of professors and students who provide the scientific community with an ongoing network of exchange and inspiration.

Prof. Luís Antonio Violin Dias Pereira was also key in helping me understand the biological behaviour of IDR. Today, he integrates the academic staff of our immersion courses.

The aforementioned professors as well as other professors, friends and colleagues who I have not mentioned in this interview

were essential not only for the continuously exchange of information we established, but also because they opened me the doors and provided me with trust and credibility.

The knowledge I acquired and the influences I had over time helped me set the boundaries of my carreer of which focus is on Implantodontics, immediate implant function and esthetic priodontal surgery.

Several cases of immediate implant placement in sockets with immediate provisional crown were performed and published by Peter Whorle in 1998. Since then, new guidelines for replacing single teeth began to guide my daily practice. In 2001, I gave my first lecture on the topic.

As time went by, other publications and discussions about filling the gap between immediately placed implants and intact sockets, and the use of connective tissue graft to maintain the volume of peri-implant tissue encouraged me to pursue better esthetic results. The experience I acquired with my study group resulted in a treatment protocol for immediate implant placement that included autogenous bone harvested from the maxillary tuberosity and used to fill the gap between the implant and the socket, as well as an immediate provisional crown with proper emergence profile.

Seven years ago, we adapted the treatment protocol developed for intact sockets and began to use it with compromised sockets. The satisfactory results yielded in the first case were repeated in following cases, which allowed us to employ the technique in even more complex cases, with different degrees of bone damage, until we began to use it in cases of gingival recession.

We improved the IDR surgical-prosthetic protocol and, in 2007, I demonstrated our prelminary results during

The IDR team: Darcymar, Marcos, Ariádene and José Carlos.

With the first group of the immersion course in IDR carried out at the convention center of Rosa Odontologia in Caxias dos Sul/RS, in 2010.

a lecture I gave at our convention center. Following Prof. Janson's advice, I presented the technique protocol and its results during lectures I gave outside Rio Grande do Sul in 2008. That happened during a meeting of Prof. Scarso's students and former students held at the Brånemark Institute in Bauru. On that occasion, we had the opportunity to present our project to Dr. P. I. Brånemark. He was excited with the results yielded with autograft used in association with the IDR technique and, later on, honored us with the preface of our book.

We have noticed that you have some preferences regarding the type of implant used, not only in terms of implant profile, but also the type of prosthetic connection. Does the IDR protocol allow external hexagon implant placement? Are there any significant biological differences regarding the esthetic results yielded in the long run?

In general, all types of implants can be used. We have treated some cases by means of the IDR technique performed with cylindrical and external hexagon implants successfully placed in the posterior region.

In spite of that, we currently have a preference for implants that provide high primary stability and resitance to vertical movement, both of which are important factors that favor implant immediate function, especially in fresh sockets. Conical or hybrid implants (cylindrical-conical) are more indicated for cases of fresh sockets. They laterally compact the trabecular bone during placement and, as a result, increase primary stability and allow better dissipation of the occlusal load.

As for the prosthetic connection, it has been proved that prosthetic platforms of smaller diamater in comparison to the implant (platform switching) decrease the stimulus for bone loss around implants while stimulating gingival sealing. Associating immediate bone graft with implants that allow the use of a platform switching connection provides greater long-term stability of peri-implant tissues.

I once had the opportunity to take part in a research coordinated by Prof. Luigi Canullo, in which he compared implant/*abutment* external hexagon connections with platform switching connections, and investigated stability at the marginal bone level. His results favored platform switching connections.

Since then, some cases of IDR were performed with abutments of smaller diameter than the implant platform. The idea was to

IDR book launch ceremony at Villa bookstore in São Paulo/SP, in 2010, with some of the coauthors: Marcos Fadanelli, Luís Antônio Violin, Dario Adolfi and Ariádene Rosa.

increase the distance between the grafted bone and the seating base of prosthetic connections. In these cases, there was a significant increase in volume of peri-implant tissues and gingival sealing, regardless of the product trademark. Therefore, platform switching implants and prosthetic connections are, today, my first choice for IDR cases, especially in esthetic zones.

José Carlos and Ariádene with Prof. P.I. Brånemark who wrote the preface for the IDR book.

Do you believe that implant surface treatment affects bone repair and, as a consequence, the positive results yielded by the IDR technique?

Implant surface treatment significantly affects how the implant behaves inside the bone. For this reason, this procedure plays an important role when implants are placed in areas of low bone density, as well as in grafted and, as a consequence, IDR-treated sites.

To my view, since the IDR technique uses essentially medullary bone, it offers a large amount of cells that favor bone incorporation and osseointegration. If the implant surface provides great cell proliferation and adhesion, bone matrix sinthesis onset time reduces and so does its association with the implant, which is significantly favorable for IDR.

The IDR technique favors immediate implant function. For this reason, it requires an implant surface that speeds up bone repair and, as a result, increases treatment previsibility. Nevertheless, similar attention must be given to implant macrogeometry, which must significantly favor primary stability.

Despite being a process of paramount importance for IDR repair, implant surface treatment should not be considered as essential. Several other factors affect the positive results yielded by the IDR technique, namely: the flapless procedure that maintains nutrition of the periosteum in the receptor site; the macro and microstructure of the tuberosity bone used as graft; the implant primary stability; the controlled and low-intensity stimulus promoted by provisional crown immediate placement; and the crown anatomical shape, with a slightly concave emergence profile that allows proper fitting of peri-implant tissues.

Does the IDR technique require the use of a specific implant surface or do all implant surfaces behave similarly?

There is no such thing as a specific implant surface required for the IDR technique. We have conducted several cases

Rosa Odontologia in Caxias do Sul/RS.

Demonstration IDR surgery performed during one of the immersion courses offered at Rosa Odontologia.

with different implant surface treatments and all of them yielded similar results.

The only exception is with regards to the commitment of the company fabricating the product. Some researches have investigated different implant surface treatments and found increased contact surface between the bone and the implant, formation of a natural structure for biomechanical tissue integration and quicker induction of the differentiation cascade of bone tissue. There is a wide offer; however, we have to value high-quality products of which excellence is proved by long-term, serious researches.

What is your opinion about the current status of biomaterial used as a therapeutic resource to treat esthetic cases? Canbiomaterial be associated with the methods employed in IDR cases?

Biomaterial have significantly developed and, except for a few marketing exaggerations, they are responsible for important achievements. Whenever necessary, I make use of this therapeutic resource. However, it is not generally applicable for all cases.

In cases of loss of buccal bone wall, it has been proved that subepithelial connective tissue graft yields more predictable results than the guided bone regeneration technique, which minimizes potential morphological changes in the gingival tissue including reduction in volume, as well as apical migration of gingival margin or papillae. Thus, in cases that require access to a donor site for removal of connective tissue graft, I prefer, whenever possible, to access the maxillary tuberosity and solve the case with autogenous bone graft taking advantage of the properties this type of graft has to offer.

Cases of defect of two or more bone walls, in which the use of biomaterial is

needed, require that we perform treatment at different stages, associating it with late implant function. Should there be a donor site available, I personally prefer and consider the immediate implant function as more advantageous. Additionally, whenever necessary, I also use autograft associated or not with connective tissue graft.

In response to your question, when biomaterial are used, I do not recommend that the concepts related to the IDR technique be employed, for instance: flapless surgery, graft stabilization by means of juxtaposition, single surgical procedure and immediate implant function. Should biomaterial be used in cases of major defects, other methods must be employed.

Is there any specific instrumentation procedure you recommend for the technique you propose?

The IDR technique is a sensitive procedure that requires proper knowledge and training, as well as the correct use of instrumentation tools that must be of high-quality and, in some cases, with a delicate and precise active tip. This is the only way we can produce the desired results, especially with regards to harvesting and fitting the bone graft into the receptor site.Throughout the development of the technique protocol, we had the opportunity to contribute with improvements in the instrumentation tools. This partnership with the German company led to the development of the IDR kit, which significantly eases the completion of the procedure.

Considering the participation of the provisional crown in the repair processes established during immediate cases, what is the importance of the stabilization of blood clot?

José Carlos with one of the groups of the immersion course on IDR during a hands-on session at his clinic.

José Carlos delivering a lecture at a national congress held during a tour organized to promote the IDR technique, in 2011.

José Carlos during a symposium on "Immediate Extraction and Implant Placement in Esthetic Zone" held in São Paulo, in 2011, with Profs. Guaracilei Vidigal Jr., Roberto Sales e Pessoa, Mário Groisman and Joseph Kan.

At an event held in São Paulo, in 2012, during which the IDR group (Darcymar, Marcos and José Carlos) gathered with friends from the ImplatePerio Institute (Júlio Cesar Joly, Robert Carvalho da Silva and Paulo Fernando M. de Carvalho).

It it possible to say that the prosthesis conditions of the gingival tissue contributes to an ideal contour?

The stabilization of the blood clot is essential for the repair of any grafting or implantation procedure. Proper graft bone modelling and fitting into the receptor site are key factors to achieve the technique success. Cortical-medullary bone graft must fit into the remaining socket walls and stabilized by juxtaposition. It must not be superimposed, so as to prevent its edges from interefering in the correct fitting of soft tissues, as well as from being lose and, as a result, not achieving the necessary stability.

After primary stabilization of the cortical-medullary graft, which aims at reconstructing the lost alveolar wall, fragmented medullary bone is inserted in the gap between the "new" alveolar wall and the implant. This second step will ensure secondary stabilization of the graft.

Final stabilization, however, only occurs after the provisional crown is installed. Should it have a correct emergence profile, slightly concave in the proximal and buccal subgingival areas, it will provide proper space for graft fitting. The provisional crown, associated with the correct apico-coronal positioning of the graft in relation to the gingival margin, functions as a "guide" for the soft tissues during the repair process, thus providing the necessary nutritional support and avoiding undesired tissue contraction.

There are cases in which implant placement by means of immediate function in esthetic zone is considered a critical procedure. How does the IDR technique behave in atypical cases? Does this protocol allow implant placement by means of late loading?

After a few years of experience, our group has reached a consensus with regard

to the three characteristics of critical cases that make the use of the IDR technique unfeasiable: Absence of residual bone necessary for implant placement and stabilization within 35 N/cm^2 or more; absence of gingival papilla; and recession above the mucogingival line. These cases require a multidisciplinary treatment approach that associates different techniques and, most of the times, two or more surgical procedures.

Even cases of gingival recession not greater than 5 mm and associated with loss of one or more than one alveolar bone wall allow the use of the IDR technique. Nevertheless, these cases require the protocol with triple graft (connective, cortical and medullary tissue graft). Several cases have been treated with this protocol and have yielded highly satisfactory results.

In some extreme cases, with defect of three or four alveolar bone walls, implants were stabilized as a result of the presence of residual bone in the apical region of the socket, with satisfactory results yielded after employing the IDR technique. These first highly complex cases have been monitored for more than 5 years and prove stable from an esthetic and functional point of view.

Late loading is not included in the IDR planning; however, it must be considered when desirable primary stability of the implant is not achieved. In these cases, we perform the technique and, as an alternative, we install a customized healing abutment that meets the requirements — related to a proper emergence profile — for fabricating the provisional crown. Nearly 4 months after surgery, we install the provisional crown.

What is the importance of computed tomography to the follow-up of these cases?

Ariádene and José Carlos with Prof. Carlos Aparício during the Spanish-version book launch ceremony in Barcelona, Spain, in 2012.

Do you believe that the cone beam imaging technique decisively contributes to change implant treatment planning?

Computed tomography was essential for the development of the technique not only because it favors early diagnosis, but also because it allows the follow-up of cases, especially with regards to the stability of reconstructed bone walls. Cone beam computed tomography is, without a doubt, our great ally due to its accuracy and accessibility.

Since the first articles about the constrast enhancement of soft tissues in cone beam computed tomography were published by Alessandro Januário et al in 2008, implant esthetic treatment planning have

become increasingly precise. This method allows us to easily identify patient's periodontal biotype, in addition to favoring the "mapping" of the alveolar bone defect, which is essential for IDR planning.

What is the current status of the first cases treated by means of the IDR technique? How long have they been monitored for? Are they considered stable from an esthetic point of view?

The IDR technique was first employed in October, 2006. We adapted the treatment protocol developed for intact sockets and used it with compromised sockets. Although it was a case of total buccal bone loss, we performed extraction, implant placement, bone reconstruction and immediate fabrication of provisional crown. All procedures were flapless and carried out in a single session, which partially refuted the literature of that time.

First IDR hands-on session in the USA at the University of Rochester, in 2012. In the photograph, Ariádene and José Carlos with the class of the course coordinated by Prof. Luís Meirelles (standing on the left).

Today, after a 7-year follow-up, the case proves stable from an esthetic and functional point of view, similarly to other cases of which treatment began shortly after the first case. Stability of the gingival margin, papilla height and tissue volume have been constant in the cases treated by means of the IDR technique. Few complications were observed during the development of the technique protocol, however, after establishing a strict protocol, we are able to avoid and properly solve them.

What are your futures expectations with regard to advances in the IDR technique?

Having the opportunity to publish our book in the English language opened us many doors to American and European countries. We have been working on a training protocol for these countries, which involves a large working team.

We have set up a research project in partnership with Loma Linda University (California) under the coordination of Prof. Jaime Lozada who will constantly require us to be present at the university. It is a multicentric international research that helps us achieve recognition for our work. Several institutions from all around the world have been researching this protocol, which significantly contributes for its development.

What can you tell us about your publications? Has the IDR technique been internationally recognized? How do you deal with the resistance of international researchers to recognize Latin-american researchers' achievements?

The first article on the IDR technique was published in March, 2008. Since then, other articles have been published in national and international journals. The IDR

technique is the theme of eight of our articles. Three other articles have already been submitted and aproved, we are just waiting for them to be published. We are going through a phase of intense scientific production, and other projects will be diclosed soon.

Our book on the IDR technique was published in Brazilian Portuguese in 2010. In 2012, we published its Spanish version. The book was disclosed during lectures and courses we gave all round Brazil, Latin and Central America, and Spain. During 2012 and 2013, our group also offerred courses in the United States, which originated the English version of the book published in New York, in March, 2014.

Presenting the technique to the scientific communities in the Middle East and Asia is also part of our plans. Moreover, some Brazilian, American and European centers and universities included the IDR technique in their therapeutic arsenal, which aroused the interest of at least five universities in conducting further researches on this technique.

Fortunately, I have noticed that the international scientific community has had an increasing respect for the Latin-american, especially the Brazilian researchers. The IDR technique has attracted the attention of important and renowned groups, which is a great honour to us.

What is your opinion about the researches on recombinant human bone morphogenetic protein and stem cells used as adjuncts in dental surgical procedures?

Any research is valid and must be encouraged. Nevertheless, it is a one-way journey. I believe that the use of recombinant human bone morphogenetic protein

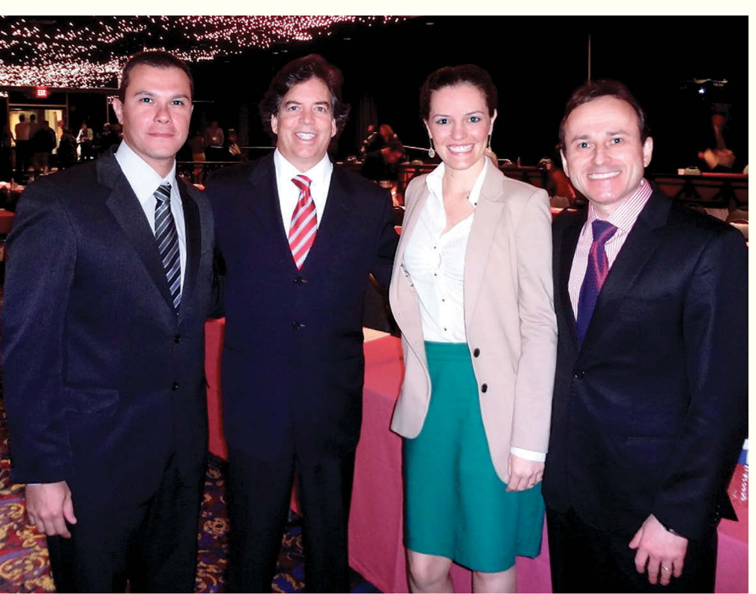
At the Andrés Bello University, in Santiago (Chile), in 2012 during the Spanish-version book launch ceremony coordinated by Prof. José Valdívia Osório.

During an event held in 2012, in the USA, with Profs. Maurice Salama and Henry Salama.

(rh-BMP2) may be a reality of every-day clinical practice, either for being as effective as hoped or as a result of economic pressure (or a result of pressure exerted by the researches funding agencies).

We cannot deny the role BMP plays in inducing bone formation: it is biological. I would be irresponsible to say that the association between rh-BMP2 and reconstructive therapies does not produce any different results. In spite of that, I believe that we are going through a very delicate moment. There has been too much fuss about it, and an unfavorable cost-benefit for the patient. Additional studies are warranted to further investigate the topic.

Conversely, the use of stem cells is something else. I believe that we will "get there" someday; however, I follow the news with caution. We might get to the point where we use stem cells not as adjuncts of dental treatment, but as the main solution for cases of tooth loss. Perhaps. We are still very far from that. I am aware that I will not be able to see such scientific advances in the dental specialties. That will be a privilege of future generations. Today, even though the media has made a big fuss about it, there is no safe, concrete or formal therapeutic protocol that authorizes the use of stem cells in humans. Nevertheless, the hopes are high.



The group during an IDR course taught in Miami (USA), in 2013. The event was organized by Prof. Anthony Sclar.

You are a renowned dental surgeon, professor, lecturer of well-attended courses inside and outside Brazil, book author and owner of a reference dental clinic. In addition to that, you also manage your family and personal life. What are your plans for the future?

I intend to go on improving, researching and disclosing the IDR technique, however, I also have other professional projects.

Outside the professional sphere, I am going through a phase of reflection. I have a great wife who helped me succeed in my professional career in all respects. Now, I intend to develop other projects inside and outside the field of Dentistry, activities that will contribute to our growth as human beings, helping people in need or dificulties. I intend to spend more time with my family, to be more present by giving and valuing the simplest things.

I believe this is the essence of life. Life! God has bestowed on me so many good things! It is high time I gave it back.

We know you are about to receive a Doctorate degree in Implantodontics. In which line of research have you written your Doctor's dissertation?

My dissertation is based on a clinical research that aims at assessing the stability

of hard and soft tissues subjected to the IDR technique employed in different periodontal biotypes, with follow-up periods of 51 to 73 months. All cases had total absence of buccal bone wall and were treated with the IDR technique.

Standardized photographs were used to assess the maintenance of gingival margin and papillae as well as soft tissue volume. I also assessed patient's esthetic parameters. Standardized photographs were also used to assess the stability of proximal crests, whereas cone beam computed tomography was used to assess the stability of buccal bone wall in the apicle, middle and vervical thirds.

Partial results produced by my research led to an article that was published in the International Journal of Periodontics and Restorative Dentistry, in March, 2014.

José Carlos with Prof. Carlos Eduardo Francischone who advises him on his Doctorate dissertation in Implantodontics.

José Carlos in front of Loma Linda University (California) with Prof. Jaime Lozada, in 2013. Together, they set up a research project on IDR.

Interviewers

Luis Rogério Duarte

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

Franklin Leahy

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original article

Level of knowledge of dentists about the diagnosis and treatment of peri-implantitis

Abstract / Introduction: *Peri-implantitis is defined as an inflammatory process that affects the bone tissue around osseointegrated implants and may therefore be a cause of dental implant failure.* **Objective:** *The objective of this study was to evaluate dentists' knowledge of the diagnosis and treatment of peri-implantitis using a questionnaire applied to dentists from the towns of Cascavel and Maringá, State of Paraná, Brazil.* **Methods:** *The sample consisted of specialists in Implantology. The same researcher explained and applied the questionnaire. With respect to the clinical characteristics of peri-implantitis, 33% of the respondents associated the condition with inflammation, 28% with radiographic bone loss around the implant, 26% with bleeding, 24% with the presence of plaque and calculus, and 5% with implant mobility. Approximately 16% of the respondents were unable to answer the questions related to peri-implantitis.* **Results:** *In the presence of a diagnosis of peri-implantitis, the most frequently used treatment was maintenance by peri-implant curettage, followed by antibiotic therapy. More than half the dentists suggested surgical treatment of peri-implantitis by guided bone regeneration combined with bone grafting. Eighty percent of the respondents considered the failure rate of osseointegration to be related to the surface, shape and material of the implant.* **Conclusion:** *We conclude that diagnostic methods and treatment modalities of peri-implantitis should be further clarified by scientific literature, since this study showed a lack of knowledge of dentists regarding specific aspects related to peri-implantitis.*

Keywords: *Diagnosis. Osseointegration. Bone resorption. Inflammation.*

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INTRODUCTION

Osseointegrated implants have been used in Dentistry with high success rates. A key factor for the long-term success of these implants is the maintenance of peri-implant soft tissue health,[1-3] given that microbial infection, also known as peri-implantitis, may occur.[4]

Peri-implantitis is defined as an inflammatory process that affects the tissues around osseointegrated implants, resulting in the loss of bone support.[5-8] The microorganisms detected in cases of peri-implantitis include *Fusobacterium nucleatum*, *Spirochaeta*, *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Tannerella forsythia*, and *Campylobacter rectus*. These bacteria have been associated with peri-implant bone loss.[9,10] The clinical signs of peri-implantitis are similar to those observed in teeth with periodontal disease and include suppuration, bleeding, pain, an increased pocket depth, and radiographic radiolucency indicating bone loss around the implant.[1,11,12]

Different types of treatment of peri-implantitis have been proposed in an attempt to guarantee survival of the implant. Similar to the treatment used for periodontal disease, peri-implant infection should be treated by eliminating the bacteria present at the site of infection [13]. Thus, antibiotic therapy combined or not with surgical methods of guided tissue regeneration and bone grafting should be used depending on the stage of the disease.[4,14,15]

In view of the scarcity of studies and lack of data on peri-implantitis, the objective of the present study was to evaluate dentists' level of knowledge about the diagnosis and treatment of peri-implantitis in dental offices in the cities of Cascavel and Maringá, Brazil, and its correlation with other factors such as implant surface and implant system.

MATERIAL AND METHODS

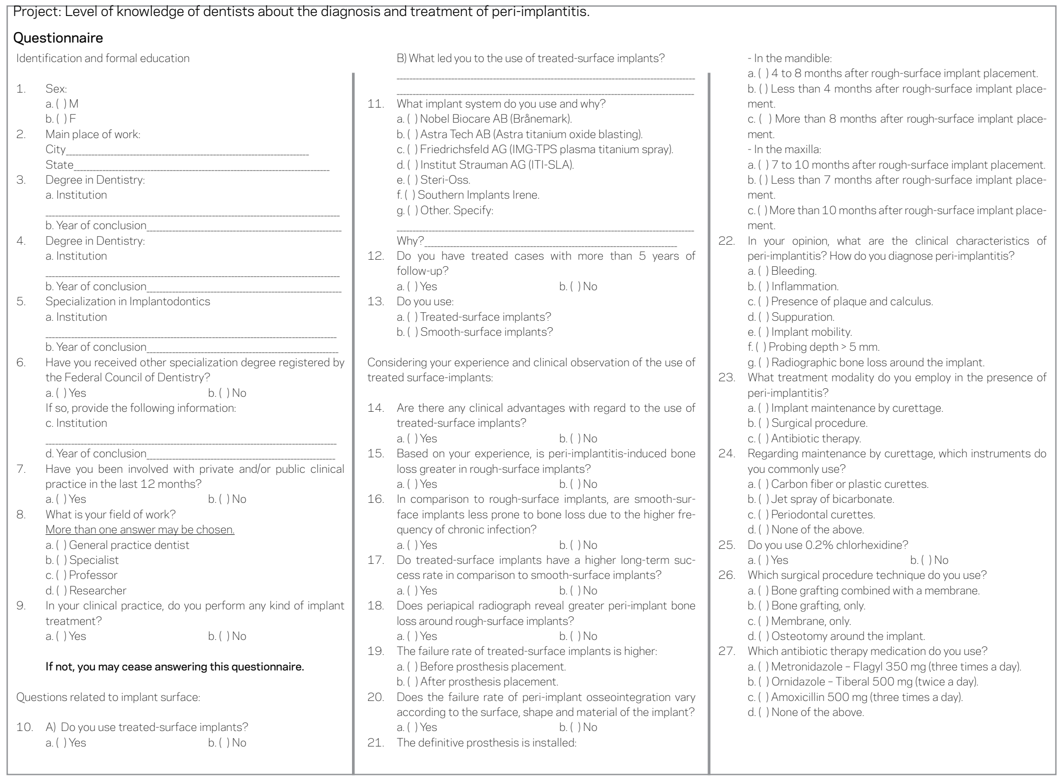
This study consisted in the application of a systematized questionnaire containing questions about: the dentist's identification, type of implant surface, clinical experience and qualification, as well as data regarding the diagnosis and treatment modalities of peri-implantitis (Fig 1).

For the interview, implant specialists living in the cities of Cascavel and Maringá, registered at the Regional Council of Dentistry of Paraná, were selected. The project was approved by the Human Research Ethics Committee of the State University of Western Paraná (Permit Nº. 253/2011-CEP, 26/05/2011).

The dentists were contacted by telephone and a visit was scheduled for the individual interview. At the beginning of the interview, a single researcher explained the objective of the study and the questionnaire, and an informed consent form was given to the professional.

The interviews were conducted in Maringá and Cascavel and involved a sample of 50 dentists, twenty-five from each city. The sample consisted of postgraduate students, teachers of higher education institutions, as well as private dentists.

The data collected with the questionnaires were entered into Excel spreadsheets (Windows XP), printed and compared to the original data on paper for the correction of possible typing errors. After tabulation, the data were analyzed using the statistical analyses for Windows program, describing the distribution and frequency of the different variables.


Project: Level of knowledge of dentists about the diagnosis and treatment of peri-implantitis.

Questionnaire

Identification and formal education

1. Sex:
   a. ( ) M
   b. ( ) F
2. Main place of work:
   City____________________
   State____________________
3. Degree in Dentistry:
   a. Institution
   ____
   b. Year of conclusion____________________
4. Degree in Dentistry:
   a. Institution
   ____
   b. Year of conclusion____________________
5. Specialization in Implantodontics
   a. Institution
   ____
   b. Year of conclusion____________________
6. Have you received other specialization degree registered by the Federal Council of Dentistry?
   a. ( ) Yes   b. ( ) No
   If so, provide the following information:
   c. Institution
   ____
   d. Year of conclusion____________________
7. Have you been involved with private and/or public clinical practice in the last 12 months?
   a. ( ) Yes   b. ( ) No
8. What is your field of work?
   More than one answer may be chosen.
   a. ( ) General practice dentist
   b. ( ) Specialist
   c. ( ) Professor
   d. ( ) Researcher
9. In your clinical practice, do you perform any kind of implant treatment?
   a. ( ) Yes   b. ( ) No

   If not, you may cease answering this questionnaire.

Questions related to implant surface:

10. A) Do you use treated-surface implants?
    a. ( ) Yes   b. ( ) No
    B) What led you to the use of treated-surface implants?
    ____
    ____
11. What implant system do you use and why?
    a. ( ) Nobel Biocare AB (Brånemark).
    b. ( ) Astra Tech AB (Astra titanium oxide blasting).
    c. ( ) Friedrichsfeld AG (IMG-TPS plasma titanium spray).
    d. ( ) Institut Strauman AG (ITI-SLA).
    e. ( ) Steri-Oss.
    f. ( ) Southern Implants Irene.
    g. ( ) Other. Specify:
    ____
    Why?____________________
12. Do you have treated cases with more than 5 years of follow-up?
    a. ( ) Yes   b. ( ) No
13. Do you use:
    a. ( ) Treated-surface implants?
    b. ( ) Smooth-surface implants?

Considering your experience and clinical observation of the use of treated surface-implants:

14. Are there any clinical advantages with regard to the use of treated-surface implants?
    a. ( ) Yes   b. ( ) No
15. Based on your experience, is peri-implantitis-induced bone loss greater in rough-surface implants?
    a. ( ) Yes   b. ( ) No
16. In comparison to rough-surface implants, are smooth-surface implants less prone to bone loss due to the higher frequency of chronic infection?
    a. ( ) Yes   b. ( ) No
17. Do treated-surface implants have a higher long-term success rate in comparison to smooth-surface implants?
    a. ( ) Yes   b. ( ) No
18. Does periapical radiograph reveal greater peri-implant bone loss around rough-surface implants?
    a. ( ) Yes   b. ( ) No
19. The failure rate of treated-surface implants is higher:
    a. ( ) Before prosthesis placement.
    b. ( ) After prosthesis placement.
20. Does the failure rate of peri-implant osseointegration vary according to the surface, shape and material of the implant?
    a. ( ) Yes   b. ( ) No
21. The definitive prosthesis is installed:
    - In the mandible:
    a. ( ) 4 to 8 months after rough-surface implant placement.
    b. ( ) Less than 4 months after rough-surface implant placement.
    c. ( ) More than 8 months after rough-surface implant placement.
    - In the maxilla:
    a. ( ) 7 to 10 months after rough-surface implant placement.
    b. ( ) Less than 7 months after rough-surface implant placement.
    c. ( ) More than 10 months after rough-surface implant placement.
22. In your opinion, what are the clinical characteristics of peri-implantitis? How do you diagnose peri-implantitis?
    a. ( ) Bleeding.
    b. ( ) Inflammation.
    c. ( ) Presence of plaque and calculus.
    d. ( ) Suppuration.
    e. ( ) Implant mobility.
    f. ( ) Probing depth > 5 mm.
    g. ( ) Radiographic bone loss around the implant.
23. What treatment modality do you employ in the presence of peri-implantitis?
    a. ( ) Implant maintenance by curettage.
    b. ( ) Surgical procedure.
    c. ( ) Antibiotic therapy.
24. Regarding maintenance by curettage, which instruments do you commonly use?
    a. ( ) Carbon fiber or plastic curettes.
    b. ( ) Jet spray of bicarbonate.
    c. ( ) Periodontal curettes.
    d. ( ) None of the above.
25. Do you use 0.2% chlorhexidine?
    a. ( ) Yes   b. ( ) No
26. Which surgical procedure technique do you use?
    a. ( ) Bone grafting combined with a membrane.
    b. ( ) Bone grafting, only.
    c. ( ) Membrane, only.
    d. ( ) Osteotomy around the implant.
27. Which antibiotic therapy medication do you use?
    a. ( ) Metronidazole – Flagyl 350 mg (three times a day).
    b. ( ) Ornidazole – Tiberal 500 mg (twice a day).
    c. ( ) Amoxicillin 500 mg (three times a day).
    d. ( ) None of the above.

Figure 1. Questionnaire answered by the dentists selected for this study.

RESULTS

In the opinion of the respondents, the clinical characteristics that can be used to establish the diagnosis of peri-implantitis are, in decreasing order: inflammation, radiographic bone loss around the implant, bleeding, presence of plaque and calculus, suppuration, a probing depth > 5 mm, and implant mobility (Fig 2).

The treatment modality most commonly used by the respondents in the presence of peri-implantitis was implant maintenance by curettage, followed by antibiotic therapy and surgical procedures. Regarding maintenance by curettage, the instruments most commonly used were carbon fiber or plastic curettes, followed by a jet spray of bicarbonate and periodontal curettes. With respect to antibiotic therapy, amoxicillin (500 mg) administered twice a day and metronidazole (Flagil, 350 mg) administered three times a day were the antibiotics most frequently selected by the dentists. Chlorhexidine (0.2%) was used for the treatment of peri-implantitis by 82% of the respondents. As for the surgical procedure, 69% of the dentists reported to perform bone grafting combined with a membrane, only 5% perform bone grafting, 4% use only a membrane, while 4% perform osteotomy around the implant, and 16% did not respond.

The sample consisted mainly of male dentists who obtained their graduate degree at private universities and have a private practice. Most respondents had received no specialty degree other than Implantology, even though Periodontics was cited by some of them.

With respect to Implantology, 94% of the respondents claimed to use osseointegrated implants in their clinical practice (Table 1); of which 42% had cases with more than 5 years of follow-up.

The use of national implant systems (Neodent and Conexão) was reported by 39% of the dentists, whereas 24% also used imported systems (Nobel Biocare AB, Astra Tech AB and Steri-Oss), and 20% did not respond to this question.

When questioned about the implant surface, 82% of the respondents claimed to use treated-surface implants while 18% did not. The reasons for the use of treated-surface implants were: better osseointegration, the benefits reported in

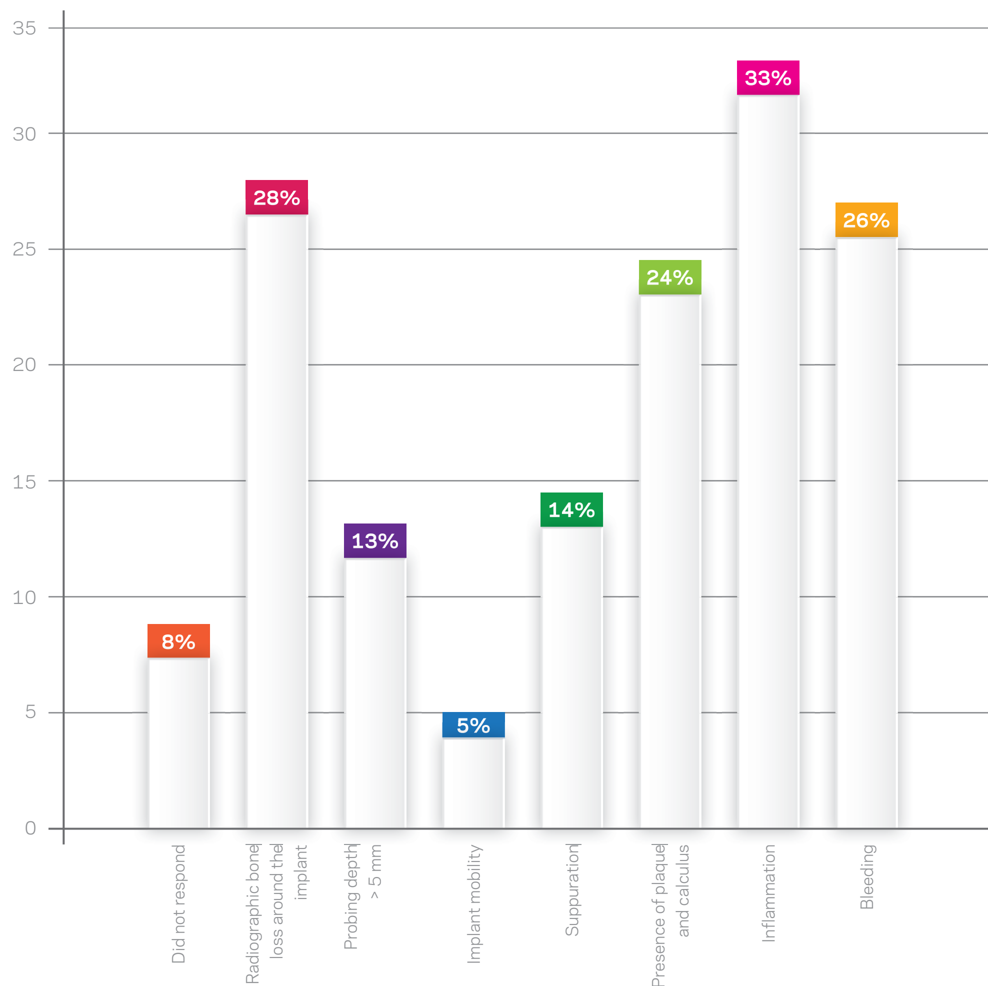


Figure 2. Percentage of responses according to the clinical characteristics of peri-implantitis..

Table 1. Respondents' profile.

Question	Answer / Sample		Percentage (%)
Sex	Male	38	76
	Female	12	24
City	Cascavel	25	50
	Maringá	25	50
University	Public	32	64
	Private	18	36
Institution of Specialization in Implantodontics	AMO	18	36
	UNIOESTE	9	18
	Did not respond	15	30
	Other	8	16
Other specialty	Yes	18	36
	No	31	62
	Did not respond	1	2
Clinical practice in the last 12 months	Yes	45	90
	No	5	10
Field of work	General practice dentist	26	23
	Specialist	34	61
	Professor	6	13
	Researcher	3	3
Involved with Implantodontics	Yes	47	94
	No	3	6

research studies and recommendation of the specialization course, as well as greater efficacy, evolution of the implants, and random acquisition (Fig 3). This question is also related to the experience and clinical observation of the use of treated surface-implants. In this respect, 66% of the respondents reported clinical advantages of the use of implants with treated surfaces, 14% reported the lack of advantages, and 20% did not respond.

More than half of the respondents did not observe greater peri-implantitis-induced bone loss in

rough-surface implants, whereas 26% reported greater bone loss and 22% did not respond. Also regarding peri-implant bone loss around rough-surface implants revealed by periapical radiographs, 44% of the respondents did not believe that bone loss is greater in cases of rough-surface implants, whereas 36% did and 20% did not respond to this question.

When asked about implants with relatively smooth surfaces, 56% of the dentists responded that smooth-surface implants are less prone to bone loss due to the higher frequency of chronic infection in the case of rough-surface implants, whereas 24% did not agree with this statement and 20% did not respond to this question.

Eighteen percent of the respondents believe that treated-surface implants have a higher long-term success rate in comparison to smooth-surface implants; 64% did not agree with this statement and 18% did not respond to this question. In contrast, 80% of the dentists responded that the failure rate of peri-implant osseointegration varies according to the surface, shape and material of the implant and only 2% responded that it does not. Eighteen percent of the dentists did not respond to this question.

With respect to the definitive prosthesis, 38% of the respondents believe that the failure rate is higher for treated-surface implants after installation of the prosthesis, 28% reported before installation of the prosthesis, and 34% did not respond to this question. A difference in the interval between placement of rough-surface implants and definitive prosthesis installation was observed: in the mandible, 46% of the respondents reported to install the prosthesis within 4 to 8 months, 32% within less than 4 months, and 22% did

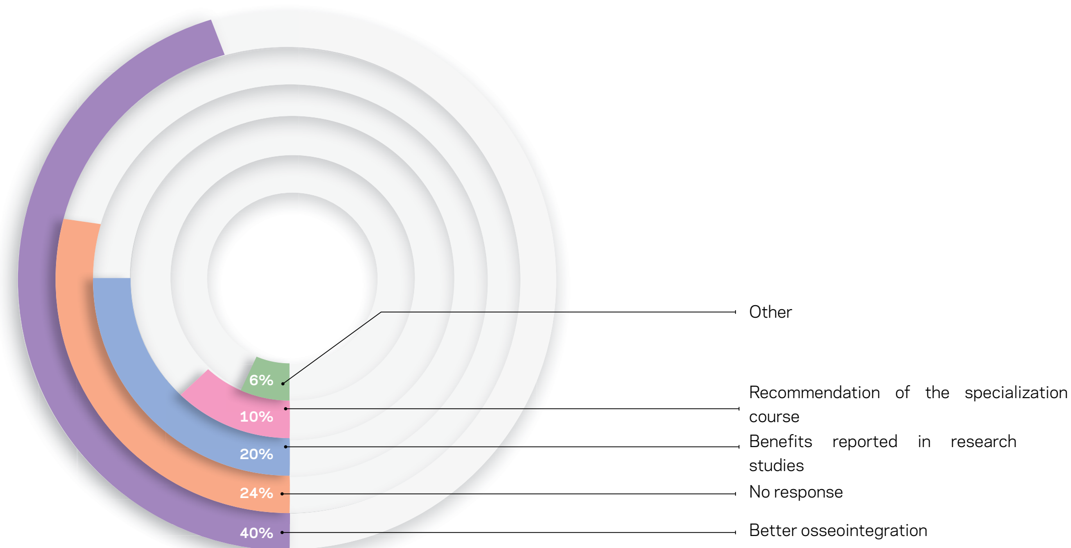


Figure 3. Percentage of the reasons for using treated-surface implants.

not respond; in the maxilla, 34% reported to install the prosthesis within 7 to 10 months, 30% within less than 7 months, 2% after 10 months, and 34% did not respond to this question.

DISCUSSION

The key parameter for the diagnosis of peri-implant mucositis is bleeding on probing under a pressure of less than 0.25 N. Peri-implantitis is characterized by changes in the level of the bone crest and bleeding on probing in the presence or absence of an increased probing depth and in the presence of purulent exudation. In addition, the onset and/or maintenance of peri-implantitis can be induced by iatrogenic factors such as excess cement, inadequate prosthesis-intermediate prosthesis adaption, overcountouring of restorations, malpositioned implants, and technical complications. Surgical trauma during implant placement and mechanical overload of the prosthesis on the host bone that exceeds its adaptive capacity can lead to the induction and persistence of bone loss.[16]

In general, osseointegration is preserved in the apical portion of the implant and peri-implant bone resorption occurs in the absence of signs of implant mobility. Implant mobility is an indicator of the lack of osseointegration, characterizing implant loss. In peri-implantitis, inflammation and bleeding on probing of soft tissues are observed in addition to bone loss around the implant and suppuration from the peri-implant pocket may occur. Bleeding on probing can be used as a predictor of bone loss. Swelling and redness of marginal tissue may not be prominent and there is generally no pain associated with peri-implantitis.[1] These were the characteristics most frequently cited by the study participants.

The characteristics of peri-implantitis are the result of the formation of a biofilm on the surface of the implant, with implant surface features influencing the amount and composition of biofilm formation. There is no sufficient evidence to draw definitive conclusions regarding the association between implant surface rugosity and biofilm formation in clinical practice,[16] although mucositis and peri-implantitis have been well defined by Lindhe and Meyle.[17]

One of the least cited clinical parameters for the diagnosis of peri-implantitis was a probing depth greater than 5 mm. A peri-implant probe does not seem to be routinely used by dentists, as demonstrated in a study on periodontal diagnosis in private dental practices in which the frequency of use of a periodontal probe by the participants was 19.3%.[18]

On the other hand, radiographic bone loss around the implant was the second most frequently cited characteristic for the diagnosis of peri-implantitis, probably because most implantologists consider bone quality to be an important parameter to evaluate implant treatment outcomes.[19]

Despite the lack of scientific studies on the diagnosis and treatment of peri-implantitis, the identification of clinical and radiographic characteristics of this disease by the dentist is important, as it allows an early diagnosis and, as a consequence, prevents implant loss, since clinically detectable mobility indicates total implant loss. In this respect, clinical analysis of probing depth, bleeding on probing, suppuration and biofilm control, as well as regular radiographic monitoring of the level of bone support, are recommended for the early diagnosis of peri-implantitis.

The approach most commonly used by the respondents in the presence of a

diagnosis of peri-implantitis was implant maintenance by curettage. According to Cerbasi,[15] mechanical treatment combined with physical means has some advantages, such as not causing damage to the implant surface since abrasive streams can reduce the biocompatibility of the surface. In addition, chemical control of bacterial plaque by irrigation with chlorhexidine digluconate solution is used for the inhibition of bacterial plaque, decontamination and elimination of local pathogens.[20]

Treatment of peri-implantitis mainly consists of decontaminating the implant surface and stabilizing bone loss around the implant. Guided bone regeneration is used in some cases.[21,22] The indications of treatment vary according to the type and extent of bone loss, implant surface coating, and the need to cover the implant.[15]

Although there is scientific evidence of the superiority of imported implants, these implants were not the most frequently cited by the respondents. Since many national systems exist in Brazil that are less expensive than imported implants, they were used by the respondents to meet the social and economic needs of the population attended.

In the study by Esposito et al,[23] rough-surface implants were more affected by peri-implantitis, whereas a risk reduction of 20% was observed for smoother machine-treated implants over a period of 3 years. Similarly to what is reported in the literature, 26% of the respondents observed greater bone loss, whereas 52% reported no increased peri-implantitis-induced bone loss in rough-surface implants.

Moreover, it is believed that the clinical advantages of rough-surface implants are the result of the development of new implant surfaces and the large financial investment of companies in the technological development of implant systems in an attempt to accelerate the process of osseointegration and installation of the prosthesis,[24-26] which was a major reason for the use of treated-surface implants by the respondents.

Despite the small number of respondents, we observed that the dentists have little knowledge of the diagnosis and treatment of peri-implantitis. Although specialists in Implantology, many of the participants did not respond to the questions. Regarding questions directly related to the diagnosis and treatment of peri-implantitis, there was contradiction and lack of knowledge of specific aspects. However, these results should be interpreted with caution, since the participants of this study represent only a small proportion of implantologists.

Considering the increasing use of dental implants, the conduct of dentists and the definitive approach to osseointegrated implants need to be reevaluated in view of the emergence of cases of peri-implantitis.

CONCLUSION

It can be concluded that the dentists interviewed have little knowledge of the diagnosis and treatment of peri-implantitis. Therefore, further studies are needed to gain more insight into the pathogenesis, etiology and treatment of peri-implantitis.

Acknowledgments

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XXIII CONGRESSO

ORDEM DOS MÉDICOS DENTISTAS

PORTUGUESE DENTAL ASSOCIATION ANNUAL MEETING

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UELI GRUNDER	CH	IMPLANTOLOGY
LEOPOLDINO CAPELOZZA	BR	ORTHODONTICS
JAVIER GIL MUR	SP	IMPLANTOLOGY
KLAUS LANG	CH	PERIODONTOLOGY
ISTVAN URBAN	HU	BONE REGENERATION
PEDRO PEÑA	SP	IMPLANTOLOGY
HUGO DECLERCK	BE	ORTHODONTICS
PADDY FLEMING	IE	PAEDIATRIC DENTISTRY
OLE FEJERSKOV	DK	CARIOLOGY AND PREVENTIVE DENTISTRY

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case report

Stem cells for bone reconstruction in sinus lifting

Abstract / Introduction: *The demand for bone reconstruction in oral rehabilitation has been growing substantially. However, patients willing to undergo reconstructive surgery want less invasive procedures with less postoperative morbidity. Less invasive bone reconstruction techniques have used bone substitutes to achieve these objectives. Nevertheless, recent studies about tissue engineering have demonstrated that stem cells, in combination with bone grafts, may potentially improve the biological characteristics of grafting material.* **Objective:** *To describe a clinical case of sinus elevation using autologous bone marrow aspirate resulting from the isolation of a bone marrow mononuclear fraction combined with Bio-Oss.* **Results:** *Five months after the combined grafting procedure (Bio-Oss + bone marrow stem cells), bone biopsies were harvested during implant placement surgery. Histological images revealed a large amount of vital mineralized tissue for a 5-month postoperative time.* **Conclusion:** *The clinical use of bone marrow mononuclear fraction combined with Bio-Oss — a xenogeneic bone substitute — in maxillary sinus elevation seems to result in good bone repair and shorter healing time.*
Keywords: *Stem cells. Bone transplant. Dental implants. Osseointegration. Bone marrow.*

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

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

INTRODUCTION

Patients have increasingly sought treatments with implants to reconstruct their smile, but the correct positioning of osseointegrated implants often requires bone reconstructions to ensure the success of subsequent prosthetic rehabilitation.[1] Bone graft procedures have become more frequent, and a growing number of patients are willing to undergo reconstruction procedures. Autogenous bone grafting, although considered as the standard reference, has been increasingly avoided. In contrast, patients have sought less invasive reconstructions with less postoperative morbidity,[1,2] which has led to exponential increases in the number of studies about autogenous bone substitutes in the last years. Alloplastic (synthetic), xenogeneic and allogeneic grafts are among autogenous graft substitutes.[3-5] However, these bone substitutes do not have osteoconductive and osteogenic properties, and have little or no osteoinductive capacity. Therefore, graft healing and incorporation take from 6 to 8 months, a period that is considered too long. In addition, the areas that receive grafts with this type of biomaterial have greater amounts of remaining graft material in acomparison to those that receive autogenous bone grafts.[6-8]

In the last years, studies on tissue engineering have advanced in the knowledge about the capacity of mesenchymal stem cells to differentiate into a variety of specialized cells to produce fat, bone, cartilage and endothelial tissues. Thus, numerous studies have focused on the development of protocols for cell treatments that may be combined with bone substitutes[4,5,9] so as to maximize the results of bone repair[2,10,11,12] and restore tissues without the removal of large amounts of autograft. Additionally, these protocols also aim at allowing healing and osseointegration to occur within a shorter period of time.[13]

Based on the knowledge that the bone marrow is the source of mesenchymal stem cells with a potential for osteogenic differentiation, and that these cells are found, in large amounts, when mononuclear cell fraction is isolated from bone marrow, some studies have been conducted to develop a method for the concentration of bone marrow stem cells. The protocol for the use of bone marrow concentrate aspirate according to density gradients has been associated with bone substitutes that may be eventually used for guided tissue regeneration (GTR). In GTR, membranes or tissue barriers are used to prevent the interference of unwanted cells — from adjacent soft tissues — which may affect healing.[14-18] GTR has been conventionally used in maxillary sinus elevation in combination with autogenic, autologous, xenogeneic or synthetic grafting.[16,18] For maxillary sinus elevation, several authors recommend the use of Bio-Oss, a xenogeneic bovine bone graft, since its physical and mechanical characteristics are similar to those of human bone, which makes it a substitute with excellent osteoconductive properties.[19-22]

This study describes a clinical case of sinus elevation using an autologous bone marrow aspirate, obtained from the isolation of bone marrow mononuclear fraction by means of a density gradient method, in combination with Bio-Oss. It also evaluated the level of regeneration provided by this treatment.

CLINICAL CASE REPORT

A 55-year-old white male patient, with good oral hygiene, was seen at the Oral Rehabilitation Clinic of São Leopoldo Mandic School of Dentistry. Teeth #16 and #17 were

missing, and the patient expected to have them replaced with fixed implant-supported prostheses. After the first visit, tests were requested. CT scans revealed great bone volume loss due to right maxillary sinus pneumatization. The treatment plan consisted of maxillary sinus elevation using xenogeneic bone graft combined with bone marrow mononuclear fraction (Fig 1).

This study was approved by the Ethics in Research Committee of the São Leopoldo Mandic School of Dentistry under protocol number 2012/0317. The patient signed an informed consent form before the study. This case report is one among several others included in an experimental Masters research.

Innitially and immediately after the operation, a hematologist collected bone marrow from the patient. The area of the right iliac crest was cleaned with 2% chlorhexidine digluconate, followed by local anesthesia with 2% lidocaine hydrochloride and puncture of the posterior upper region of the iliac crest using a 40 x 12 mm needle with a reamer (Lee-Lok, Minneapolis, MN, USA) (Fig 2).

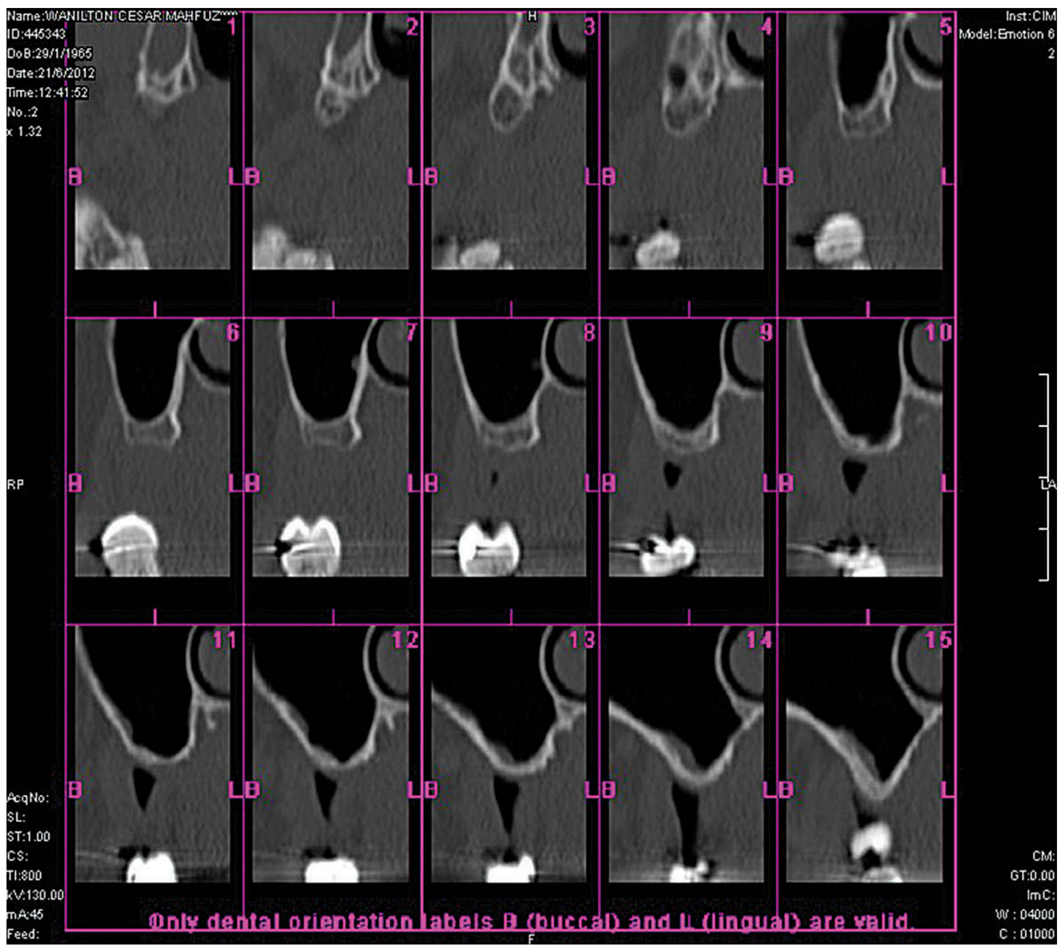
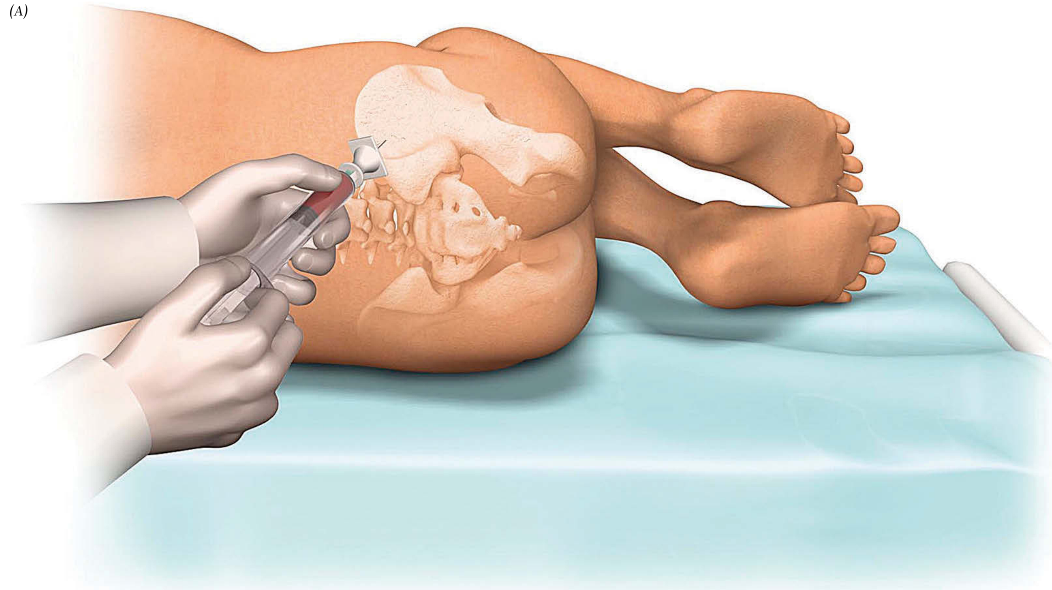


Figure 1. Sagittal CT scan reveals absence of bone tissue (maxillary sinus pneumatization) in right posterior maxilla.

This study followed a protocol to obtain bone marrow mononuclear fraction by density gradient isolation using Ficoll-Histopaque (Sigma-Aldrich, St Louis, MI, USA) according to the following method of cell layer separation: 1) collection of 4 mL of bone marrow (BM) aspirate from the posterior iliac crest; 2) in a laminar flow clean bench, BM aspirate was transferred to a 15-mL conic tube with 4 mL of buffer saline solution (PBSx1) and homogenized using a pipette; 3) the content was slowly transferred to another 15-mL conic tube containing 8 mL of Ficoll-Histopaque to avoid mixture of phases; 4) centrifugation at 400 g for 30 minutes; 5) division of



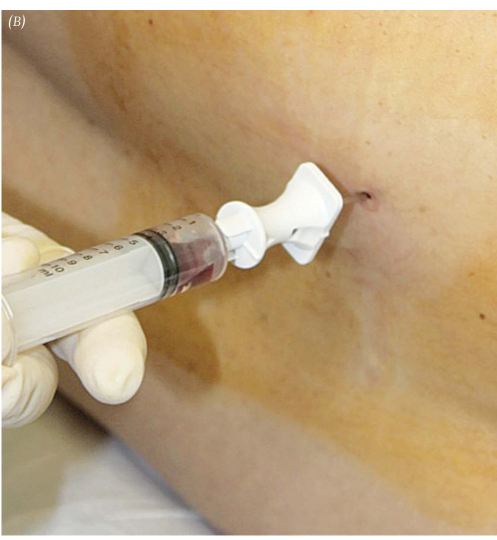


Figure 2. (**A**) Illustration of the punctured region in the iliac crest; (**B**) autogenous bone marrow collection.

phases was monitored: in the upper phase, there is plasma and its soluble contents; in the interface, there are mononuclear cells; in the layer immediately below, there is Ficoll-Histopaque; and at the lowest point, there is a layer of cell sediment with erythrocytes and granulocytes; 6) using a precision pipette, the interface of mononuclear cells was removed and transferred to another conic tube containing 4 mL of PBS and homogenized; 7) centrifugation at 200 g for 10 minutes at room temperature to obtain a new pellet at the bottom of the tube; 8) removal of supernatant; 9) re-suspension of the pellet in 1 mL of PBS to obtain final cell suspension (Figs 3 to 6).

During the laboratory procedures, the patient received 1 g amoxicillin and 4 mg dexamethasone, extra oral asepsis with 2% chlorhexidine digluconate and intraoral asepsis with 0.12% chlorhexidine digluconate mouthwash before the beginning of the surgery.

Local anesthesia with 2% mepivacaine hydrochloride and 1:100.00 epinephrine was injected into the sulcus and the palatine region. An incision was made over the crest, slightly lingual, and a single vertical

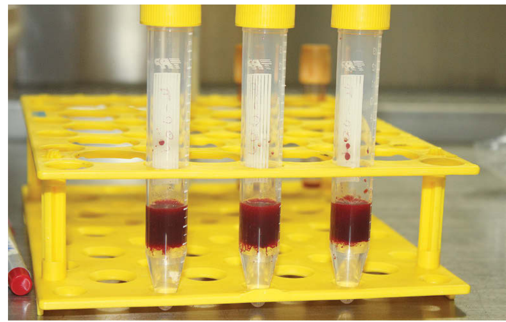


Figure 3. Conic tubes with autogenous bone marrow aspirate and Ficoll-Histopaque.

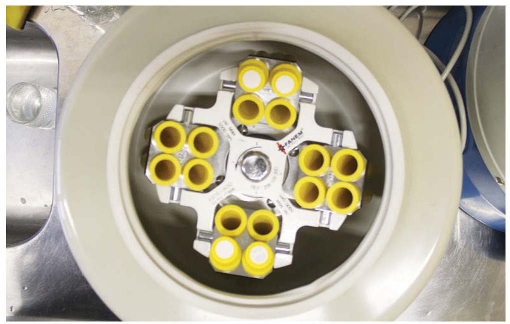


Figure 4. Centrifugation at 400 g for 10 minutes.

Figure 5. Pipetting the supernatant.

Figure 6. Bone marrow mononuclear fraction.

incision with a #15 scalpel was made to raise a total flap and provide access to the region. Using large diameter diamond and spherical steel burs, an ovoid bone cavity was created with total stripping to access the floor of the maxillary sinus. This cavity received the graft after the Schneiderian membrane was raised and displaced. After this surgical approach, the grafting material was prepared in combination with the bone marrow mononuclear fraction (BMMF) obtained according to the method described above. A sterile dappen dish with a lid was used for homogenization. The dish was filled with the content of one vial of xenogeneic bone substitute (Bio-Oss 2g Large Particles 1.0-2.0 mm, Geistlich, Switzerland) for BMMF addition and homogenization. After complete filling and composite graft accommodation, an absorbable collagen membrane (Bio-Gide, Geistlich, Switzerland) of adequate size was positioned to fully cover the surgical cavity that received the graft. Mononylon 5.0 was used for suture. The following postoperative medications were prescribed: 500 mg amoxicillin every 8 hours for 3 days and 35 drops of 500 mg/mL metamizole sodium every 6 hours while the patient felt pain. Ten days after the operation, the suture was removed with no further complications (Figs 7 to 11).

Five months after grafting, new CT scans were obtained, the region was reopened and surgical cavities were prepared for the placement of implants using a 2-mm trephine bur. At the same time, two bone samples were removed and fixed in 10% formaldehyde immediately after removal. After that, two osseointegrated morse

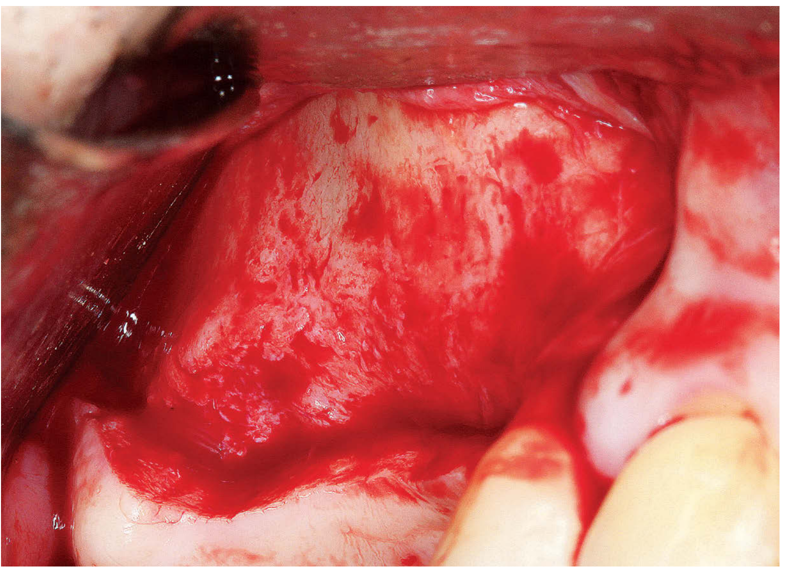


Figure 7. Total flap raising and bone exposure.

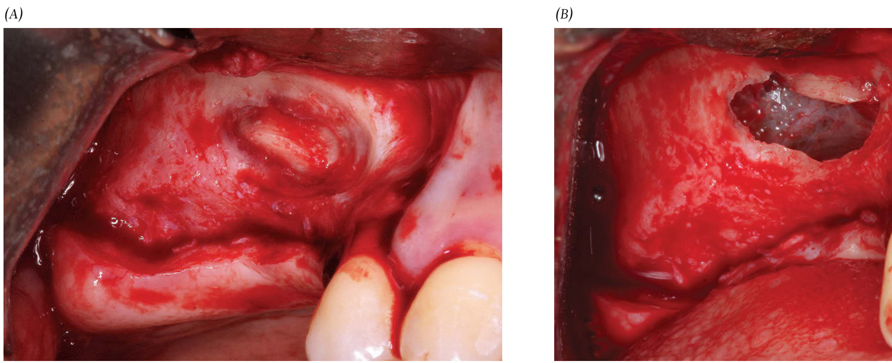


Figure 8. (A) Opening access to the maxillary sinus floor; **(B)** Schneiderian membrane raising and access to the maxillary sinus floor.

Figure 9. Xenogeneic bone substitute combined with BMMF.

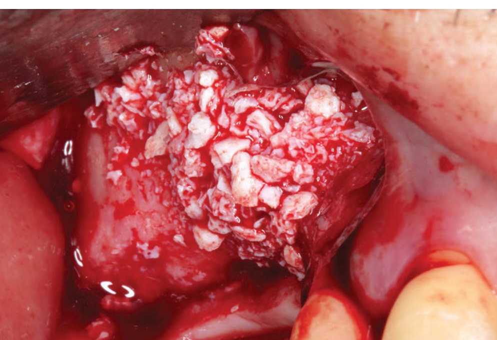


Figure 10. Maxillary sinus floor filled with xenogeneic graft combined with BMMF.

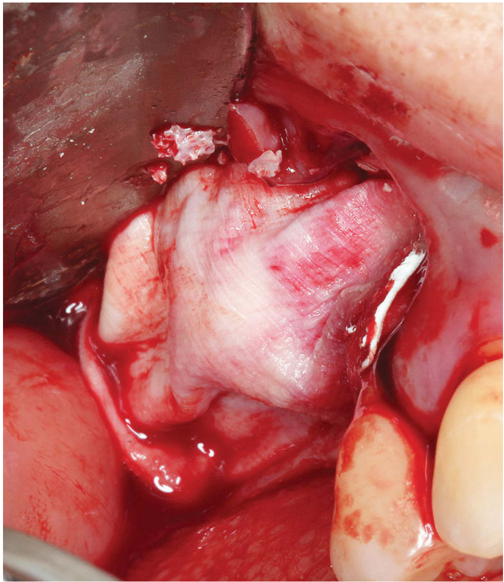


Figure 11. Placement of membrane (Bio-Gide) as a barrier over the grafted region.

taper implants were placed (4.0 x 10 mm, morse taper Black Fix, Titanium Fix, Brazil) (Figs 12,13,14).

Later on, histological hematoxylin-eosin (HE) stained slides were prepared and examined under light microscopy at 100x magnification.

RESULTS

A large amount of vital mineralized tissue was found five months after the surgery, which is less than recommended for grafts without any combination with cells. An histological image of another case that received only the Bio-Oss graft, with no cell

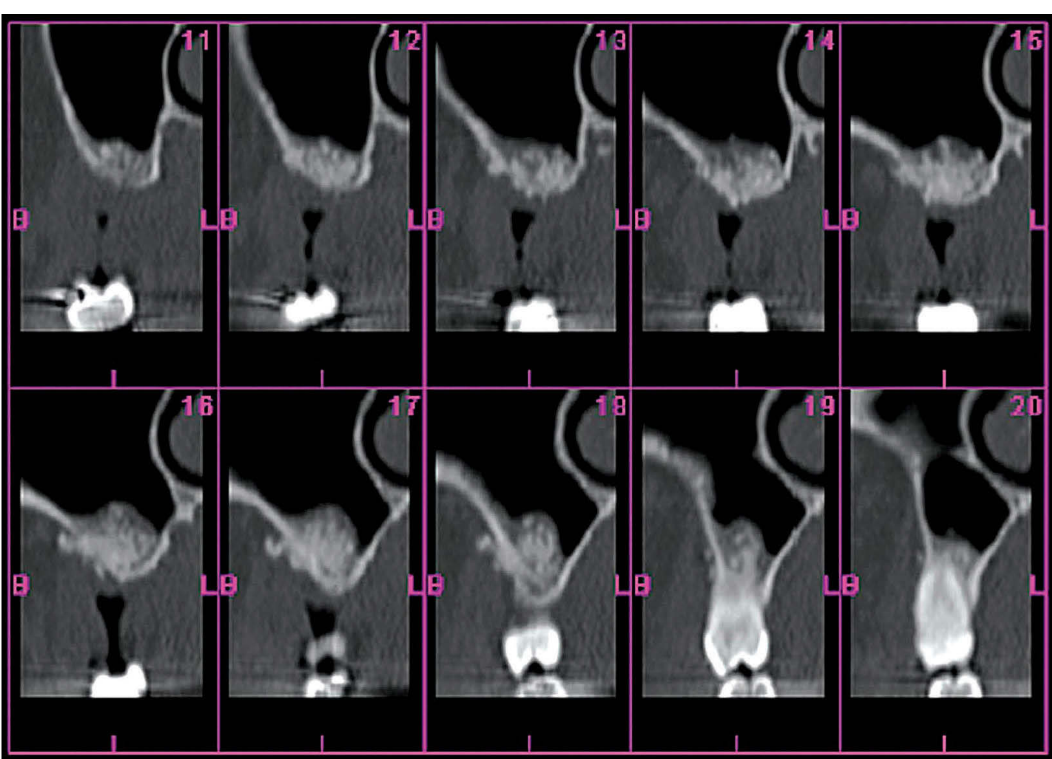


Figure 12. Sagittal CT scan reveals bone tissue in right posterior maxillary sinus previously pneumatized.

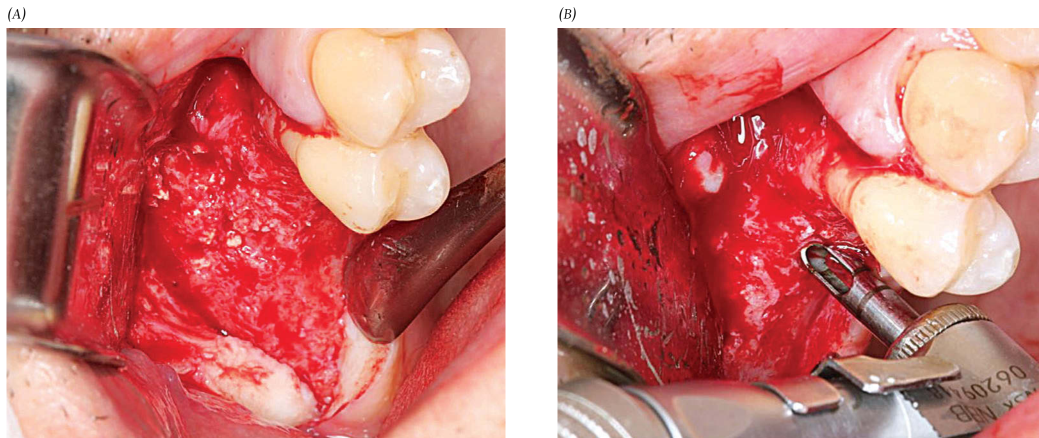


Figure 13. (A) Full-thickness flap raised; **(B)** bone perforation using a 2-mm trephine bur.

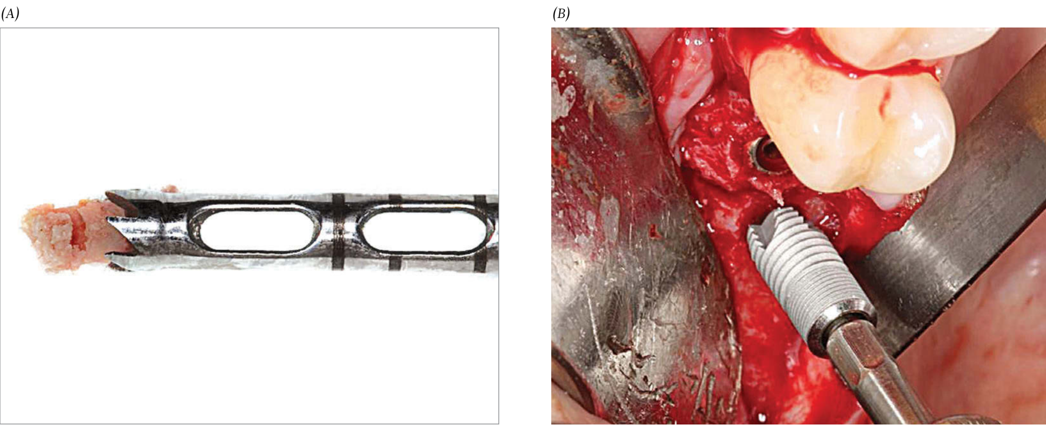


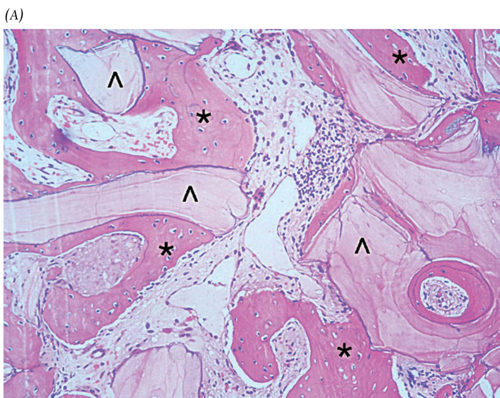
Figura 14. (A) Specimen for histological examination, collected using a 2-mm trephine bur; **(B)** placement of osseointegrated implants.

treatment, is provided for comparison and shows results at 6 months after conventional sinus elevation surgery using a lateral bone access and sinus cavity that received a xenogeneic graft (Bio-Oss 2 g large particles 1.0-2.0 mm, Geistlich, Switzerland), as recommended by the manufacturers (Fig 15B).

DISCUSSION

This clinical report described the use of Bio-Oss, a xenogeneic bone substitute, in combination with bone marrow mononuclear fraction isolated by density gradient for maxillary sinus elevation using lateral access. Analyses confirmed tissue

(A)



(B)

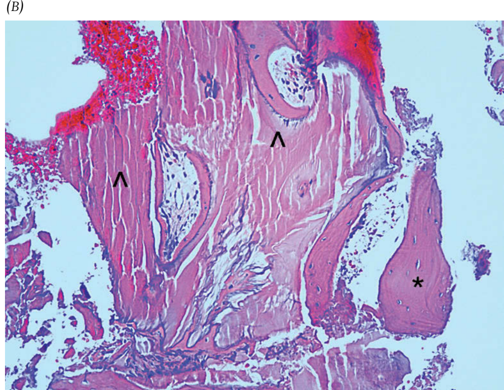


Figure 15. A) Histological image (HE staining) under 100x magnification of the specimen obtained from the clinical case described herein, in which the region of the maxillary sinus received a Bio-Oss (^) graft combined with mononuclear fraction (five months after surgery). There is a large amount of vital mineralized tissue (*) around the Bio-Oss (^) particles. **B**) Histological image (HE staining) under 100x magnification shows another clinical case of the maxillary sinus that received a Bio-Oss (^) graft without any combination with mononuclear fraction (six months after surgery). There is a smaller amount of vital mineralized tissue (*) around the Bio-Oss (^) particles.

quality after a short period of time in comparison with the time required to perform the conventional technique. This has also been reported by other scientific studies employing methods of use of fresh or processed bone marrow.[13,23]

Autogenous bone grafting is considered as a standard reference due to its osteoinductive, osteoconductive and osteogenic properties. Nevertheless, it presents greater surgical morbidity, since it requires two of more surgical sites in cases of greater amount of donor tissue. Extra-oral sites may have to be used, which increases the operative risk as well as the surgical costs, and generates postoperative discomfort. For this reason, a growing number of patients avoid this technique.[1,2] This problem has led to a search for bone substitutes that may replace autogenous bone. However, such substitutes do not have the osteogenic and osteoinductive qualities that are inherent to autogenous grafts.[8]

Choosing biomaterial with physical, chemical and mechanical characteristics as close as possible to autogenous bone has become increasingly necessary due to the need to use the area that received the graft for the placement of osseointegrated implants. International studies report that Bio-Oss, a xenogeneic bovine bone substitute, is a material with characteristics that are very similar to those of human bone, which is associated with its good osteoconductive properties.[24-28] The main disadvantage of lyophilized xenogeneic bone, or any other bone substitute, is the lack of factors that promote osteogenesis and osteoinduction. Deficiency in these factors require longer healing and osseointegration time (from 6 to 8 months) in comparison to the use of autogenous bone of which cellularity and growth factors provide it with a high osteogenic and osteoinductive potential. This potential, inherent to autogenous grafts, reduces the time necessary for bone healing down to 4 to 6 months.[13,23]

The literature has reached a consensus regarding the aforementioned fact. For this reason, methods to enrich bone substitutes have been investigated using cells from the bone marrow of the recipients. Different studies have described collection techniques and the use of fresh bone marrow directly inserted into the surgical sites,[1,2] as well as the culture of mesenchymal stem cells obtained from the bone marrow, as well as bone marrow concentration techniques. The study reported herein used the method described in another study published by the same group of authors, which confirmed that the use of Bio-Oss, a lyophilized xenogeneic bone graft, combined with autogenous bone marrow mononuclear fraction increases the amount of vital bone and reduces the time of graft healing, as confirmed in this clinical report.[23] This method has also been recently published in a book.[29]

Cell culture techniques employed in humans have disadvantages over the use of fresh or concentrate marrow, such as the cost of laboratory processing and the waiting time between collection and graft surgery, because of the large number of cells necessary to perform the procedure and the risks of contamination,[30] as well as the ethical principles involved in the duplication of cells for which there are still no markers. For this reason, the use of a protocol of autogenous bone marrow aspiration and concentration of its mononuclear fraction using density gradient may be a feasible method to improve the quality of the graft material, substantially reduce graft healing time and increase bone quality in the area that receives the graft and that, later on, receives the osseointegrated implants with sufficient torque to achieve adequate primary stability. Moreover, surgical time is not longer, and bone marrow harvesting generates minimal discomfort in the donor area.

CONCLUSION

The clinical use of a bone marrow mononuclear fraction concentrate combined with Bio-Oss, a xenogeneic bone substitute, in maxillary sinus elevation seems to result in good bone repair and shorter healing time.

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case report

Morse taper implant: A case report

Abstract / Introduction: *Improvements in oral rehabilitation techniques allow esthetically demanding treatments to yield better and more predictable results.* **Methods:** *This paper reports a case of root fracture of tooth #11 treated by means of reverse planning comprising the following steps: tooth extraction, immediate implant placement associated with guided bone regeneration and immediate temporary crown placement. Due to its biomechanical stability and bacterial sealing properties, a Morse taper connection implant was used to reduce peri-implant bone resorption, preserve periodontal tissue health and yield highly satisfactory esthetic results. The temporary tooth had been previously fabricated in accordance with the symmetry of adjacent teeth, lips and gingival tissue, which resulted in a pleasant smile.* **Conclusion:** *It is reasonable to conclude that establishing an appropriate three-dimensional positioning of implants is not enough for Implantodontics. It requires that an appropriate planning be associated with an efficient connection so as to place an implant in accordance with patient's periodontal biotype, thus predicting a satisfactory emergence profile, in addition to recovering patient's esthetics, function and speech.*

Keywords: *Three-dimensional imaging. Dental implant immediate loading. Dental implant design.*

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

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

INTRODUCTION

Root fractures are adverse injuries often seen in dental clinics. However, when extraction and immediate implant placement in esthetic zones are required, oral rehabilitation often becomes a clinical challenge.[1]

After extraction, the socket may be immediately filled with an implant so as to minimize physiological reactions associated with bone loss, either in height or thickness.[2]

The bone surrounding the peri-implant area determines not only implant longevity, but also its biomimetic adaptation.[3] Bone crest preservation increases the probability of papilla formation, a key factor for yielding good esthetic results.[4]

After implant placement, bone crest undergoes resorption and remodeling. Some of the factors that contribute to this process are as follows: the distance between implants (minimum: 3 mm) or between the implant and the tooth (minimum: 2 mm); the distance between the contact point and the bone crest (minimum: 5 mm); the depth at which the implant is placed; the type of implant or connection, and the macro design of the cervical area of the implant.[5]

In the clinical case reported herein, a Morse taper connections were used to ensure minimal peri-implant bone resorption and to yield optimal esthetic results.

Morse taper connections have been widely used, whether commercially or clinically, due to their great biomechanical stability and efficient bacterial sealing, both of which are a result of the connection design.[6] Planning in Implantology should not be limited to achive correct three-dimensional positioning of implants; but should ensure that implants be positioned in a way that predicts a viable prosthetic solution, an efficient connection and an optimal esthetic performance.[7]

OBJECTIVE

This study describes a protocol used for the three-dimensional positioning of a Morse taper connection as well as for immediate esthetic restoration performed by means of reverse planning.

CLINICAL CASE REPORT

A female patient sought dental care with chief complaint of tooth mobility. Initial examination revealed that she was in good general health. Clinical and radiographic examinations revealed root fracture (Fig 1).

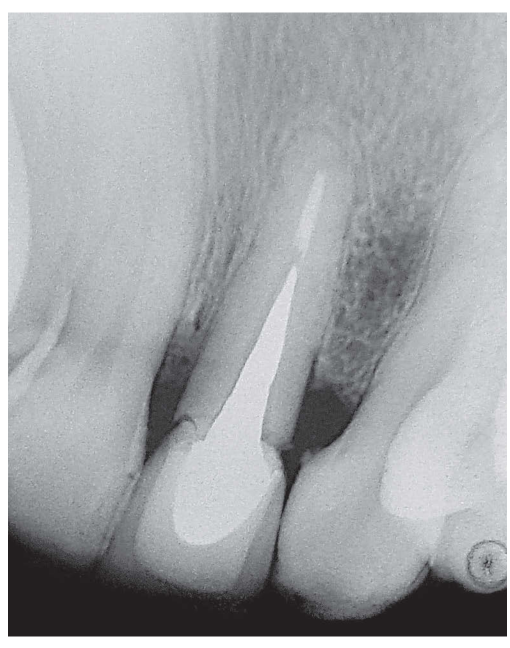

Figure 1. Periapical radiograph (tooth #11).

Impressions of the maxilla and mandible were taken, and casts were mounted on an articulator. After examining extra- and intraoral photographs as well as laboratory tests, treatment was planned on the basis of the following: shape, function, esthetics and gingival zenith of the ceramic crown placed over tooth #11 were in harmony with adjacent teeth and tissues; consequently, diagnostic waxing was not performed. Finally, a surgical guide was prepared using 1-mm-thick acetate film.

The first part of the surgery was the administration of infiltration anesthesia with 4% articaine hydrochloride and 1:100,000 epinephrine into the bottom of the sulcus of tooth #21 using an electronic anesthesia machine (Morpheus). Additional anesthesia was administered to the branches between the nasopalatine and the greater palatine nerves, and completed with mucosal anesthesia.

After positioning the surgical guide, the socket was perforated to prepare the bone bed to receive the implant (Fig 4). A paralleling pin was placed in the surgical socket to assess the three-dimensional positioning of the implant (Fig 5). Perforation was performed

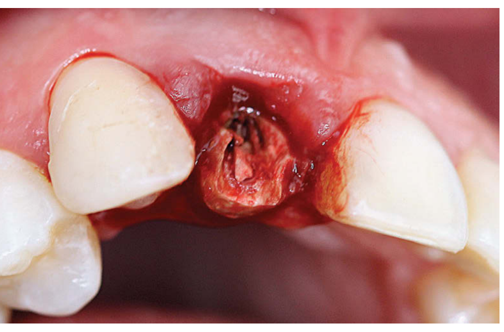

Figure 2. Tooth #11 and its root fractured into two fragments.

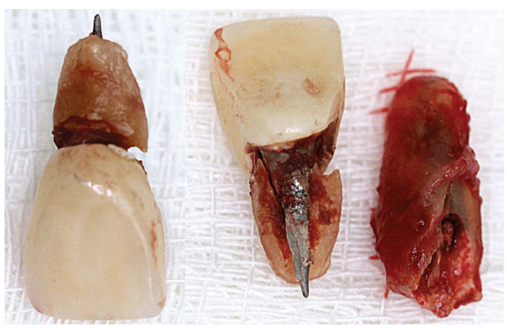

Figure 3. Tooth # 11 after extraction.

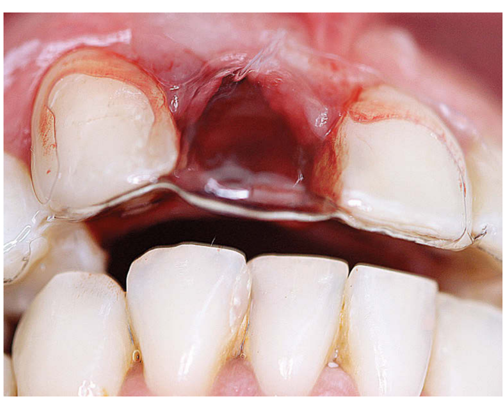

Figure 4. Surgical guide positioned for three-dimensional implant placement.

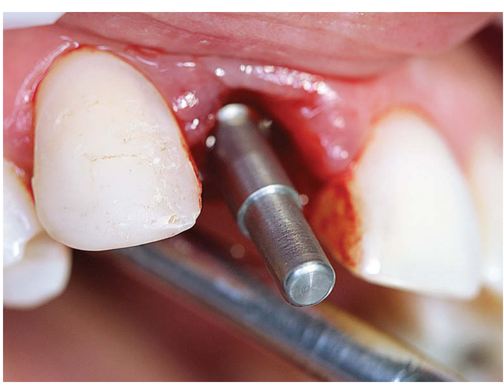

Figure 5. Paralleling pin already in place.

so as to position the paralleling pin along the incisal edge of teeth # 21 and #12 (Fig 6).Implant positioning was previously determined according to the type of fixation of the prosthesis to be installed, a cemented prosthesis.

Subsequently, the implant was placed at 40 rpm (Fig 9). In this clinical case, an Axiom Anthogyr Ø 4.0 x 14.0-mm Morse taper connection implant was used (Figs 7, 8).

The gap formed between the implant and the tooth socket was filled with Extra Graft XG 13, an osteoconductive biomaterial composed of bovine hydroxyapatite and type I collagen (Fig 10). Sutures were not necessary, as the flapless technique was used for immediate implant placement.

After the surgical phase, the prosthetic phase was initiated: an Anthogyr abutment (4 mm diameter, 7 degrees inclination and 3 mm transmucosal length) was screwed onto the implant (Fig 11). The temporary tooth, previously manufactured in acrylic resin according to implant shape, function and esthetics, was then cemented. The abutment screw orifice was sealed with 2% chlorhexidine gel, Styrofoam and light-curing resin (Fig 12).

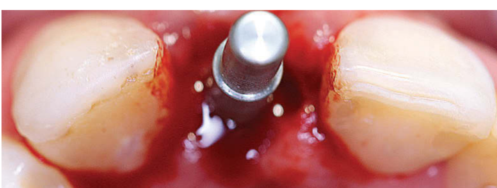

Figure 6. Occlusal view of paralleling pin and adjacent teeth.

Figure 7. Axiom Anthogyr Ø 4.0 x 14.0mm implant.

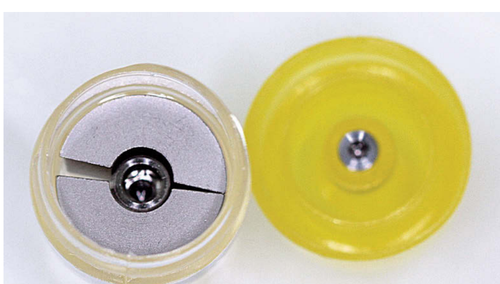

Figure 8. Axiom Anthogyr Ø 4.0 x 14.0mm implant.

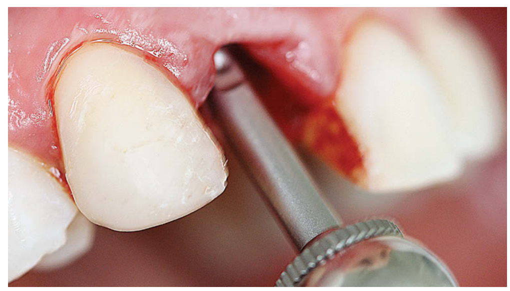

Figure 9. Implant placement.

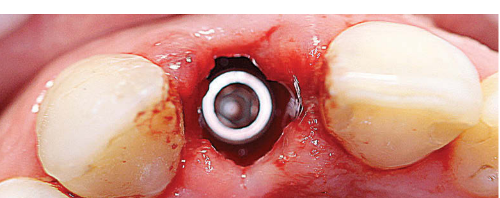

Figure 10. Gap between tooth socket and implant.

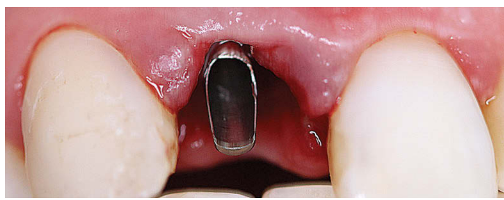

Figure 11. Anthogyr abutment (4.0mm / 7 degrees / 3 mm).

To adapt the temporary tooth to the prosthetic abutment, an acrylic resin ring was prepared over the abutment analog.[7] This ring was manufactured by means of the brush-on (Nealon) technique: resin was applied from the cervical to the occlusal region of the prosthetic element, except for the area of the abutment screw, so as to allow the correct placement of the ring over the prosthetic element (Figs 13 to 16). This ring was installed over the abutment already in place, and resin was placed inside the temporary tooth to keep the ring in place. The correct positioning of this set was achieved by placing the temporary tooth inside the surgical guide and taking the whole set to the adequate position in the mouth (Figs 17, 18).

Given that the temporary tooth was manufactured by means of reverse planning, after finishing and polishing, it required minimal occlusal adjustments, which ensured the adequate three-dimensional positioning of this element (Fig 18).

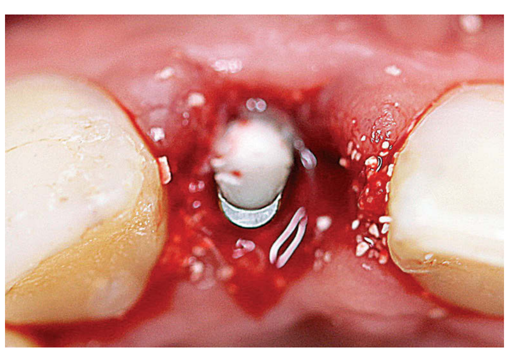

Figure 12. Abutment screw orifice sealed with 2% chlorhexidine gel, Styrofoam and light-curing resin.

Figure 13. Beginning of resin ring manufacturing using the Nealon technique.

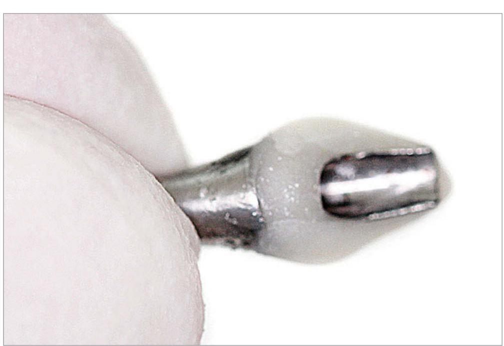

Figure 14. Resin ring with opening in the area corresponding to the abutment screw.

Figure 15. Resin ring manufactured over abutment analog.

Final treatment results should be predictable when substantial esthetic rehabilitation is planned,[7] in which case reverse planning plays an important role, as it simulates the end result before the patient undergoes any procedure. This planning is based on an initial evaluation conducted according to a careful clinical analysis of imaging studies and models mounted on articulators, as well as on diagnostic waxing[8]. This sequence of procedures enables the patient to visualize treatment plan, and the dentist to ensure predictability of treatment results. Together with reverse planning, the Morse taper connection implant, chosen to treat the case reported herein, also contributed to treatment success.

The Morse taper connection favors the stability of soft tissues around the implant, and provides better biological sealing between the implant and the abutment, which results in less bacterial infiltration[9]. Another advantage is the fact that it provides greater stability between the abutment and the implant, which reduces the need for cauterization and, consequently, preserves the health of peri-implant tissues.

The Morse taper connection implant may be subdivided into surgical and prosthetic platforms, whereas in other connections both platforms are very close to each other. This characteristic allows it to be placed according to the patient's

Figure 16. Temporary tooth positioned inside the surgical guide.

Figure 17. Temporary tooth inside the surgical guide and placed in the patient's mouth.

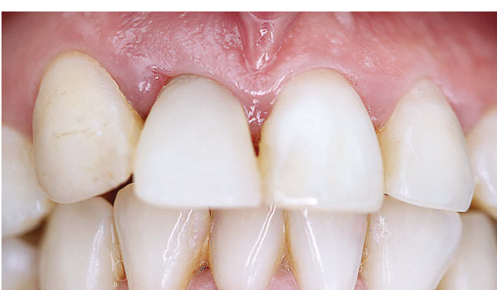

Figure 18. Adequate three-dimensional positioning of the temporary tooth in relation to adjacent teeth.

periodontal biotype. For example, when the patient has a thin biotype and low bone line, the Morse taper connection implant should be used to ensure that the prosthesis has a satisfactory emergence profile.[7]

The patient reported herein had an intermediate profile, but, as esthetic demands were high, the implant was placed 3 mm subcrestally (Fig 19). Moreover, the depth at which the surgical platform was placed was determined according to the type of prosthetic element to be used and the periodontal biotype, so that the resulting emergence profile was adequate.

Other factors of great importance in selecting the prosthesis were as follows: the inter-occlusal space, between the implant of tooth # 11 and the opposing tooth; and sufficient thickness for the placement of metal, opaque, ceramics and its texture. These dimensions may be measured by checking the space between the prosthetic abutment already in place and the surgical guide, which should be at least 4 mm.

The characteristics of the final ceramic crown, such as thickness, size, fit and esthetics; should coincide with the temporary tooth, since the latter is the prototype of the future prosthesis.

Finally, after placing the temporary tooth and fitting the emergence profile, adjacent tissues have to be conditioned to ensure repair — even if secondary — and their stabilization in the long run. In the case reported herein, the temporary tooth was placed inside the surgical guide and taken to the mouth, which ensured proper fit and adequate three-dimensional positioning.

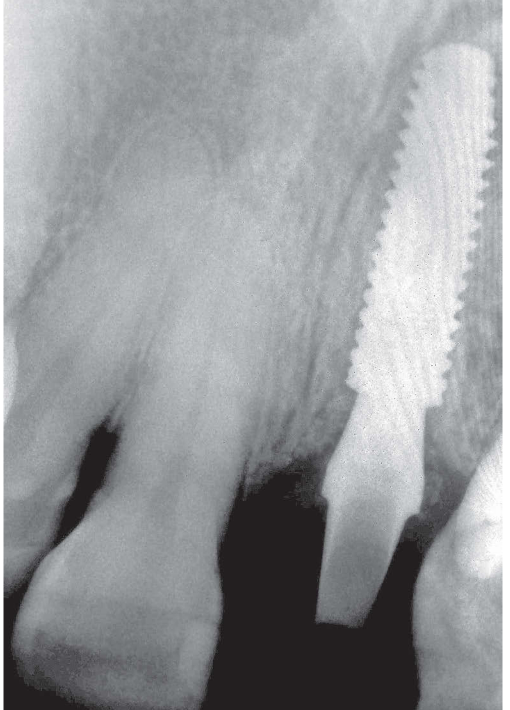

Figure 19. Implant placed 3 mm subcrestally.

CONCLUSION

Planning in Implantology is not limited to achieving correct three-dimensional positioning of an implant, but also to placing it at a position that ensures a viable prosthetic solution, combined with an efficient connection and an optimal esthetic performance. Such results are possible when using reverse planning, since it predicts prosthetic results and provides restoration of esthetics, form and function, thus ensuring dentist's safety and patient's satisfaction.

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case report

Optimization of guided bone regeneration in post-extraction socket by means of the Fugazzoto technique

Abstract / Introduction: *During the surgical planning for prosthetic rehabilitation performed by means of osseointegrated implants, we often face some limitations such as pneumatized maxillary sinus, in which case we can make use of alveolar regeneration and bone grafting procedures.* **Objective**: *This article discusses and reports a case of alveolar regeneration.* **Results**: *Treatment resulted in bone gain that allows implant placement without further grafting procedures.* **Conclusion**: *Guided bone regeneration (GBR) provided predictability and optimization of surgical treatment.*
Keywords: *Maxillary sinus elevation. Bone regeneration. Oral surgery. Maxillary sinus.*

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

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

INTRODUCTION

Rehabilitation of the posterior maxilla performed by means of implant-supported prostheses can be quite challenging. Horizontal and vertical bone resorption after tooth extraction, low bone quality and pneumatization of the maxillary sinus require careful diagnosis and clinical approach if the patient intends to rehabilitate this area with osseointegrated implants.[1] With the advent of sinus floor elevation, bone regeneration and bone grafting techniques, the possibilities of rehabilitating the posterior maxilla by means of implants have expanded.[2-11]

Several techniques for sinus floor elevation are described in the literature. The first one was the lateral window approach described by Tatum[12] in 1986; followed by Summers,[13] in 1994, with a more conservative crestal approach performed by means of osteotomes. In 1999, Fugazzotto[1] described a modification of Summers technique, which consists in using the inter-root septum to elevate the maxillary sinus membrane. This procedure is performed with the aid of a trephine bur and osteotomes.

Bone resorption and remodeling require the use of grafting and alveolar filling material to preserve bone architecture. Although autogenous bone graft remains as the standard reference for this type of procedure, some synthetic material of remarkable quality fulfill this role satisfactorily, with the advantage of presenting lower post-operatorative morbidity.[14]

With a view to preventing the risk of bacterial infection, grafted areas must be covered and stabilized by a mechanical barrier, thus providing healing of soft tissues by first intention.[15,16] The literature presents several methods employed to accomplish such closure, namely: modified flaps, pedicle grafts, free gingival tissue graft and synthetic material.

This article discusses, through a case report, the possibility of increasing bone height by means of non-traumatic sinus floor elevation performed through Fugazzotto's technique, followed by alveolar filling with particulate composite bovine bone and surgical site closure with free gingival tissue graft.

CASE REPORT

A 52-year-old female patient, with good systemic health, sought the clinics of the Center for Study and Research in Dental Implants of the Federal University of Santa Catarina (CEPID/UFSC) with chief complaint of coronal destruction of tooth #26.

Clinical examination (Fig 1) confirmed the presence of a healthy periodontium and a small amount of remaining tooth which had already undergone an unsuccessful attempt of endodontic treatment. Due to root fragility and low predictability of prosthetic rehabilitation, it was decided on the extraction of the remaining tooth and placement of an implant in the region of tooth #26.

Cone Beam CT analysis (Fig 2) revealed maxillary sinus pneumatization in the region of tooth #26, which hindred immediate implant placement. For this reason, it was decided on non-traumatic sinus floor elevation performed during extraction.

Surgical planning was based on the atraumatic extraction of the compromised tooth without flap elevation, but by means of periotome and forceps, so as to preserve the integrity of the alveolar septum (Fig 3) and avoid absorption of the buccal wall.

After extraction, socket curettage was performed to eliminate potential infections caused by apical root remnants. Maxillary sinus elevation carried out by means of Fugazzotto's technique was initiated with osteotomy of 5mm in depth performed with a

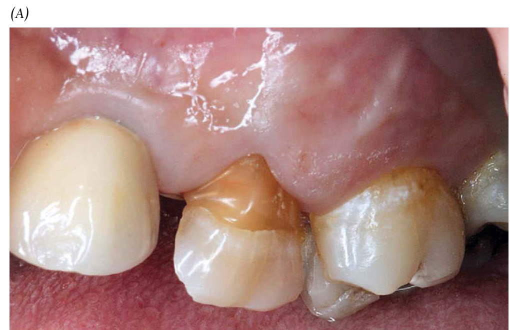
trephine bur of 5 mm in diameter (Neodent®, Curitiba - Brazil) (Fig 4). The procedure included the septum and nearly 50% of the socket (Fig 5A), leaving a bone base of 2 mm below the septum. Subsequently, maxillary sinus elevation was performed with the use of an osteotome similar in size to the trephine bur, pushing the septum and its floor into the sinus (Fig 5B). For socket filling, particulate composite bovine bone (Genmix/Baumer®, Mogi Mirim - Brasil) was used (Fig 6).

With a view to achieving first intention healing, free gingival tissue graft was performed (Fig 7A) and sutured to the remaining edges of the socket (Fig 7B). After 7 days, the suture was removed and a cone beam CT was taken to assess the bone volume obtained. After 30 days, complete healing of soft tissue was observed (Fig 8). Further tomographic examinations (Fig 9) revealed that the maxillary sinus membrane was lifted in approximately 3 mm by means of the inter-root septum and the filling material, which, after bone formation/maturation, enabled implant placement with an appropriate length.

DISCUSSION

Extraction of compromised teeth for subsequent implant rehabilitation requires maximum alveolar bone preservation, thus increasing surgical predictability and keeping the gingival architecture.

(A)



(B)

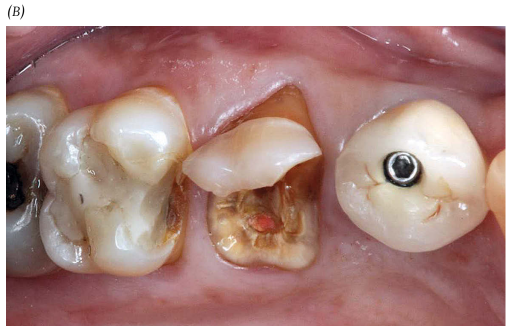
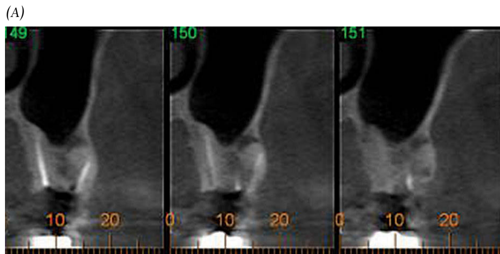


Figure 1. Initial clinical aspects: **A)** Buccal surface of tooth #26. **B)** Occlusal surface of tooth #26.

(A)



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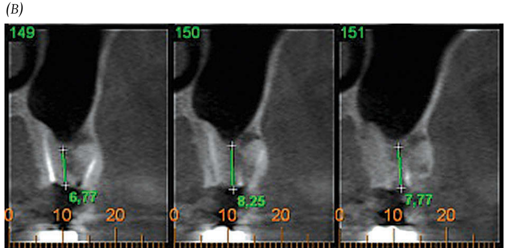


Figure 2. A) Pre-operative cone beam computed tomography. **B**) Pre-operative cone beam computed tomography with measures that evince remaining bone height.

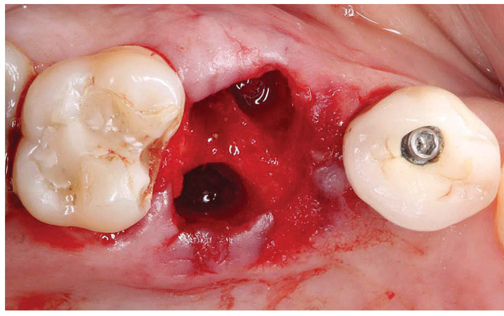
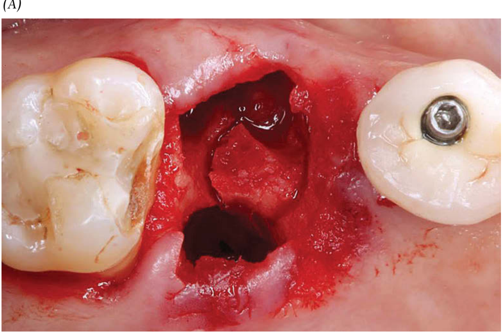


Figure 3. Tooth socket after atraumatic extraction. Note the maintenance of the inter-root septum.

Figure 4. Trephine bur with diameter proportional to the alveolar septum and 50% of the extraction socket.

(A)



(B)

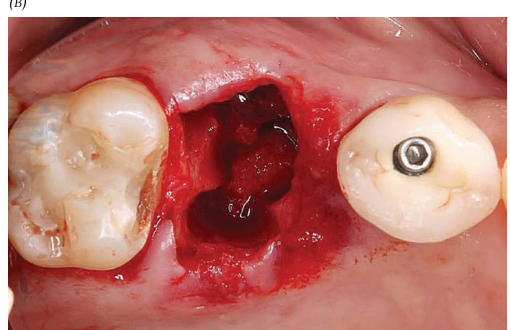


Figure 5. Occlusal view of the socket. **A**) After trephine bur is used. **B**) After osteotome is used.

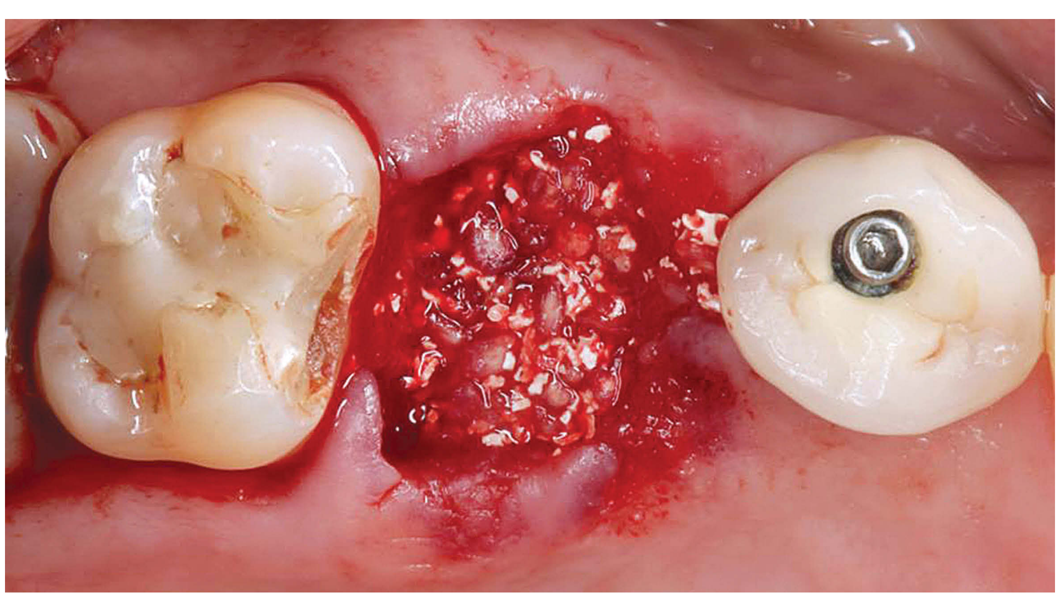


Figure 6. Socket filling with particulate composite bovine bone.

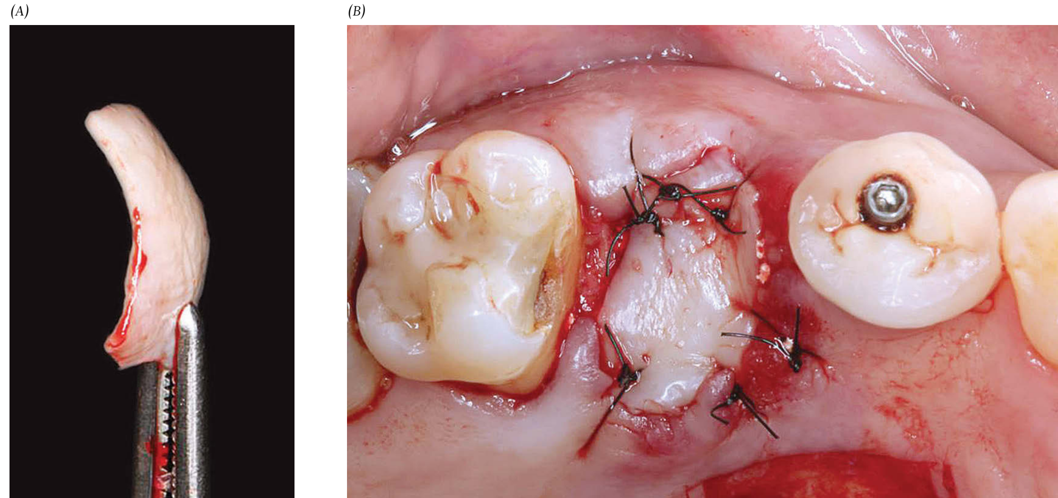


Figure 7. A) Harvested free gingival tissue graft. **B**) Free gingival tissue graft sutured to the surgical socket.

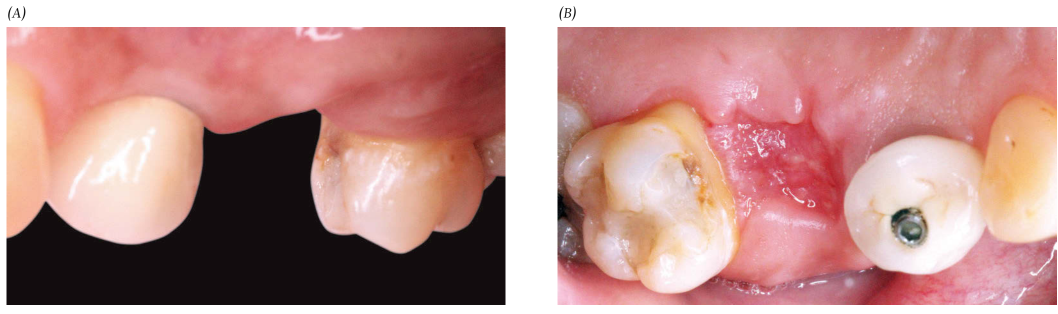


Figure 8. Post-operative phase after 30 days: **A**) Buccal clinical view. **B**) Occlusal clinical view.

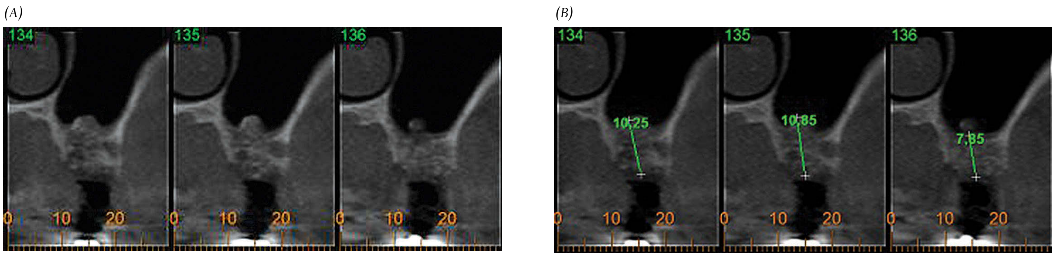


Figure 9. A) Post-operative cone beam computed tomography. **B**) Post-operative cone beam computed tomography with measures that evince bone height gain near 3 mm.

Therefore, atraumatic extraction should be performed whenever possible.[17] Regeneration procedures have been increasingly used, since the literature demonstrates significant changes in alveolar bone crest after extraction when these procedures are not performed, which may hinder subsequent implant placement.[18]

Some cases present limiting factors that hinder the surgical procedure, namely: atrophic maxillary ridge or pneumatized maxillary sinus. In these cases, elevation of the maxillary sinus membrane proves a feasible option, as it aims to achieve sufficient bone height for implant placement in the posterior maxilla. The high success rates and predictable results yielded by this procedure are widely described in the literature.[19,20,21]

The traumatic approach performed by means of the lateral window technique, followed by the elevation of the membrane and cavity filling, as reported by Tatum,[5] is indicated when bone crest thickness is between 2 and 4 mm. The atraumatic or crestal approach of Summers[6] requires a minimum height of 5 to 6 mm, and the elevation of the membrane is carried out through osteotomes. In the case reported herein, the remaining bone septum was 6 mm thick, which would allow atraumatic elevation of the maxillary sinus; however, the procedure could only be carried out after healing of the post-extraction socket. Nevertheless, it is not possible to predict the rate of maxillary sinus pneumatization and/or alveolar reabsorption, for this reason, a more complex surgery, such as the opening of a lateral window, could be required. In this case, Fugazzoto's technique allowed greater predictability and security in maintaining bone architecture, indispensable for implant placement.

It is worth noting that, whenever a patient is submitted to any surgical procedure, one must consider the advantages and disadvantages of the options available. The traumatic technique provides greater bone gain, however, it is a more invasive procedure that increases postoperative morbidity. The crestal approach, on the other hand, is minimally invasive, but with limited bone gain.[22] Due to the aforementioned limitations, Fugazzotto's technique[1] was chosen to increase the maxillary sinus floor immediately after extraction of the upper molar. Fugazotto[1] highlighted that the association of his technique with alveolar regeneration is key to maintain the three-dimensional architecture of the socket, avoiding major structural changes and enabling the maintenance of buccal-lingual and apico-coronal architecture.

The use of bone grafting and regeneration material has been widely discussed in the literature. Even though the best results are still obtained with autogenous bone, biomaterial have proved extremely effective, in addition to providing high predictability.[23,24] Xenogeneic biomaterial, hydroxyapatite enriched with calcium sulphate and hydroxyapatite enriched with magnesium are among bone substitutes. They were tested by Crespi, et al[25] who demonstrated that implant placement over these substrates did not influence the clinical results, even though further histological studies are required. Other comparative studies reveal that associating swine, bovine and synthetic bone substitutes is a valid procedure when compared with autogenous bone used alone. Schlegel et al[26] compared bovine bone substitute (Bio-Oss) with autogenous bone, assessing their effectiveness as material used for maxillary sinus filling. Their study revealed that excellent results can be achieved with the biomaterial.

Therefore, the present study used bovine biomaterial composed of organic and inorganic particles to fill the cavity, which not only decreased the amount of operated sites, but also post-operative morbidity. Furthrmore, the choice for this type of biomaterial was based on its structural properties that merge the advantages of good speed bone formation / resorption and, at the same time, enable maintenance of the socket as a result of the particles with low resorption rate.[27,28]

Primary flap closure is key to bone regeneration. Several authors recommend the use of pedicled connective tissue graft, since it provides better esthetics, graft nutrition and, as a consequence, greater predictability.[29.30] In spite of that, since the present case did not require esthetic outcomes, free gingival tissue graft was performed to seal the surgical socket, which allowed healing by second intention.

CONCLUSION

Fugazzotto's technique enables sinus floor elevation to be performed at the same time of tooth extraction, providing great predictability to GBR, decreasing treatment time and the number of surgical procedures, and optimizing treatment with osseointegrated implants.

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Membranes function in bone fracture healing and bone surgery

Abstract: *"Essence" is the primary reason for being, using or understanding something. The essence of a membrane, regarding the mechanisms of socket bone repair, is to replace the injured or damaged periosteum so as to prevent non-osteogenic cells from colonizing blood clot and exudate, forming a fibrous or adipose tissue to fill the "empty" spaces. Bone cells are slower in comparison to other cells; and the membranes, which substitute the periosteum, preserve or restore the bone cavity which becomes an area restricted to bone cells. Furthermore, due to its organization and productive capacity, the periosteum plays an essential role in bone reconstruction and remodeling, adapting the bone to potential functional demands.* Keywords: *Bone repair. Membranes. Periosteum. Bone fracture.*

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The importance of the periosteum to bone repair

Understanding the adaptive, reaction and/or repair capacity of the periosteum helps us understand the use of membranes, repair or epithelial regeneration guides for maxillary surgery.[1]

Craniofacial bones are of intramembranous origin. They grow by apposition and resorption of periosteal and cortical surfaces and sutures. Even after the growth phase, the bones of the face may undergo morphological changes often caused by apposition and resorption of periosteal surfaces, unlike endochondral bones that form and grow from a previously formed cartilage.

Cases of long bone fracture often cause areas of hyaline cartilage to form (Figs 1, 2, 3), which does not occur in the maxilla and the mandible, as bone cells do not go through this phase to directly deposit bone matrix and build bone as an anatomical structure.

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

The structure of the periosteum

The periosteum is firmly inserted into the surface of cortical bone through Sharpey's fibers that, in turn, are inserted into bone matrix of collagen nature. The periosteum connective tissue[3] is divided into two different contiguous layers:

1) ***The outer layer****, mainly formed by fibroblasts. It is predominantly fibrous and aims at providing protection to the surface. This layer originates collagen fibers that are periosteally inserted into the subjacent cortical bone.*

2) ***The inner layer*** *of the periosteum is directly related to the cortical bone surface and is characterized for being rich in osteoblasts, pre-osteoblasts, osteoprogenitor cells, tissue stem cells, clasts and other cells in smaller numbers.*

The center of the periosteal structure is intensely vascularized by a network formed by small vessels that branch off towards the bone surface. This intermediate zone formed by numerous capillaries could represent a third layer that differs in terms of thickness from the periosteum.The periosteum provides the bone structure with blood supply.

The **surgical opening** of the periosteum is a traumatic procedure that implies in loss of biological feasibility of the cortical bone surface layer. The osteocytes of the surface layer die and the bone matrix layer that hosted them undergoes resorption; with or without compensatory bone neoformation, depending on local conditions.

The most important indicator of bone vitality and feasibility is the presence of osteocytes

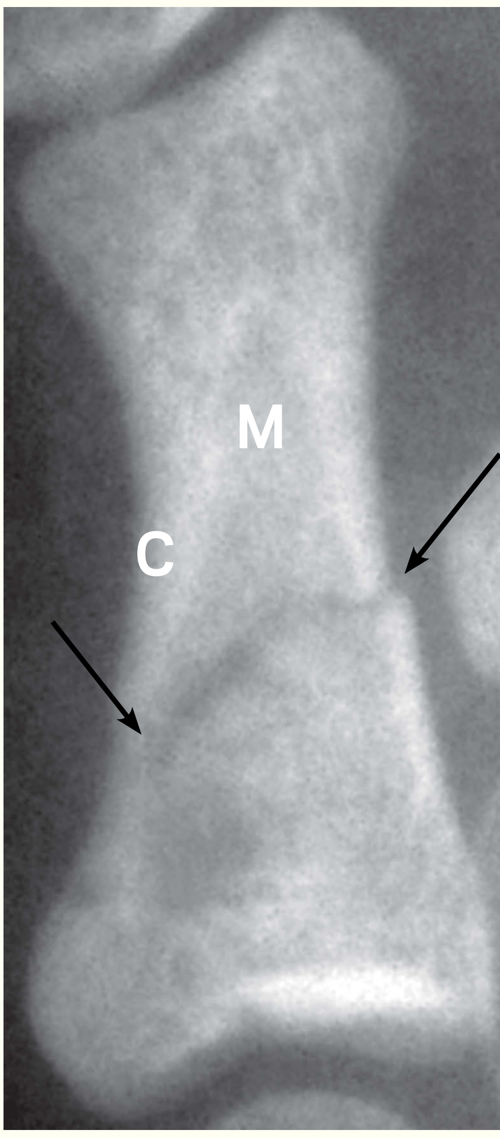


Figure 1. Long bone fracture used in this text to explain the process of bone repair and the importance of the periosteum. The arrows indicate the bone fracture line which is the epicenter of bone repair.
C = cortex; M = bone marrow

within bone lacunae or osteoplasts. Without osteocytes, the bone is likely to undergo resorption and to be repositioned posteriorly. When periodontal surgery is performed on free cortical surfaces with thin alveolar cortical bone, the cleft flap technique causes the periosteum to adhere to the cortex, thus avoiding surface resorption and, as a consequence, preventing bone dehiscences and fenestrations.

Adaptive and reaction capacity of the periosteum

The adaptive and reaction capacity of the periosteum promotes local phenomena that depend on:

a) *the degree of stimulus or offending agent: it must be durable and low.*
b) *the level of local mediators: mild inflammations tend to accumulate mediators that, if slightly increased, induce osteoproductive phenomena. Conversely, these same mediators, if accumulated at high levels, induce resorption.*
c) *structural and functional integrity: preserving the periosteum cells as well as the periosteum circulatory tree is essential to produce new bone layers.*

Bone turnover has mediators of systemic and local action. Parathyroid hormone, calcitonin, vitamin D[3] and estrogens are among systemic mediators. Their action is continuous and associated with the serum level of calcium and phosphorus. Conversely, it does not depend on local stimuli.

The local mediators of bone turnover play an important role, particularly in bone areas that require tissue adaptation and reactions against stimuli such as the action of muscular forces accidently applied or applied for orthopedic purposes.

Whenever forces are applied, the cells undergo alterations in shape as well as at the level of oxygenation due to alterations in blood flow. Deformation of the cytoskeleton and hypoxia are natural inducers of cellular stress, in which case mediators that are essential for cellular intercommunication, particularly cytokines, growth factors and products of arachidonic acid, are released. The phenomena induced by these mediators aim at restoring normality. Whenever physical events, such as force, change into biological reactions, it is possible to say that a phenomenon of "translation" or transduction was established. In other words, a physical phenomenon becomes biological, which can be summarized by the term mechanotransduction.

A classic example of mechanotransduction associated with osteogenesis is the transmission of tension to suture fibers caused by intracranial pressure, which stimulates bone neoformation and, as a result, bone growth.[4] The force exerted by muscles and tendons increase cortical thickness as well as trabecular bone thickness and density, which represents an adaptive response to increased functional demand. It is possible to say that structural morphology is directly related to the type and degree of functional demand applied to a given structure.

In some cases, the stimulus or offending agent induces cellular stress and triggers a low-intensity inflammatory process that ceases with time if the cause of inflammation is eliminated, or remains if the cause remains. The inflammatory exudate and infiltrate are important alternative sources of local mediators of bone turnover.

BONE FRACTURE REPAIR AND THE IMPORTANCE OF THE PERIOSTEUM

Long bone fracture is the first example that helps us understand the idea of bone repair (Fig 1). The cortical bone has vessels and cells filling the Haversian and Volkman's canals, as well as the inner periosteum and the endosteum, that also cover bone trabeculae. The trabeculae, as well as the cortex, also have many undifferentiated and differentiated cells that, if necessary, originate new cells, as it is the case of bone repair, especially bone surface repair, of the endosteum. The bone marrow is another important source of bone repair cells and vessels, even if it is not hematopoietically active or red, in other words, in case of adipose or fibrous bone marrow.

In the fracture line between the cortex and the spongy bone and below the periosteum, serous exudate rich in blood clot and fibrin form (Fig 2A). The periosteum may or may not break by the lesion that caused the fracture. Nevertheless, its repair capacity is quicker than that of other bone components. The arrival of neutrophils with an insignificant amount of bacteria causes the acute phase of inflammation to evolve to repair within the first hours, which stimulates the phenomena of cell proliferation, differentiation, migration and synthesis in neighboring cells and cleaning of the area by the action of macrophages. The two major sources of mediators that cause the aforementioned phenomena are the macroplatelets of the fibrin network and the macrophage hyperactiveted by phagocytosis.

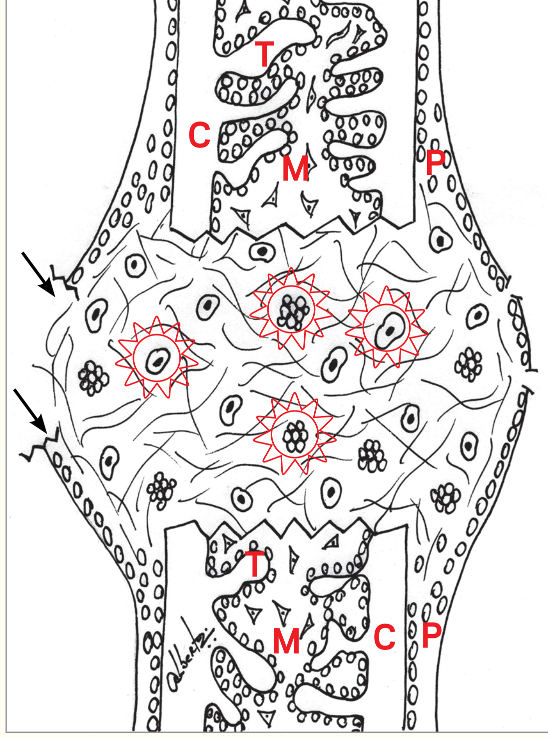
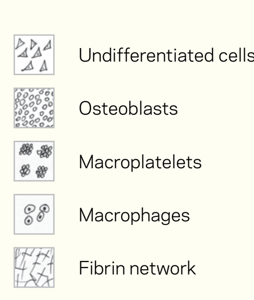


Figure 2A. At the fracture site, the inflammatory exudate and blood clot are characterized by an exuberant fibrin network that provides anchorage to cells and platelets. While the macrophages clean the area, the platelets release a large amount and variety of mediators (arrows) so as to stimulate the neighboring cells to differentiate, migrate and colonize the area. Partially injured periosteum (arrows).
P = periosteum; C = cortex; T = trabeculae; M = bone marrow



Angiogenesis is a process that originates in the endothelial sprouts of blood vessels neighboring the periosteum and the endosteum (Fig 2B). Following their path, undifferentiated young cells or pre-differentiated cells go on colonizing the fibrin network that is formed. Within a few hours or days, blood clot and/or serofibrous exudate changes into a jelly-like tissue that represents the young granulation tissue which is rich in: 1) neoformed vessels; 2) recently-arrived young differentiated cells; and 3) macrophage and leukocytes remaining from the acute phase of inflammation (Fig 2B). The presence of foreign bodies, bone fragments and necrotic areas physically hinders the formation of granulation tissue.

In the granulation tissue, the recently-differentiated cells that migrated to that area start to synthetize new extracellular bone matrix, predominantly of collagen nature, which will be further mineralized. They are of endosteal and periosteal origin and assume the genotype and the phenotype of young osteoblasts — synthesizers of bone matrix.

Initially, from the outer surface to the center, the synthesis occurs with primary,

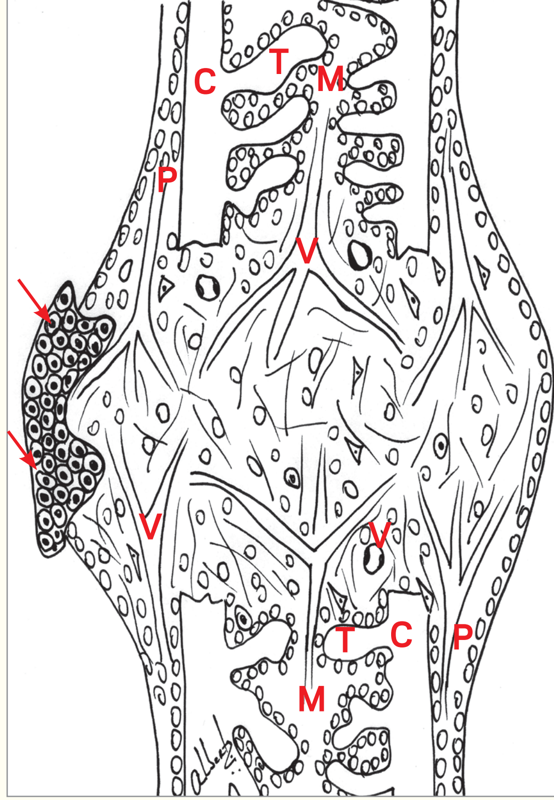
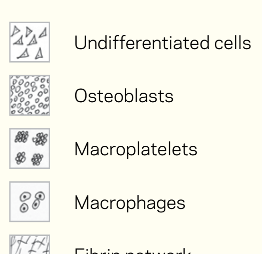


Figure 2B. Neoformed vessels (V) replace blood clot and exudate. The vessels are formed from bone marrow (M), periosteum (P), undifferentiated cells and young osteoblasts that gradually migrate and replace the fibrin network by extracellular matrix. As a result, granulation tissue is formed.
Injured periosteum (P) is replaced by a temporary plug formed by hyaline cartilage (arrows) which prevents the cells of neighboring fibrous connective tissue from entering into the bone environment.
V = neoformed vessels; M = bone marrow; P = periosteum; C = cortex; T = trabeculae.



Undifferentiated cells
Osteoblasts
Macroplatelets
Macrophages
Fibrin network

embryonic or immature bone tissue, which is characterized by its high number of cells, low level of mineralization and disorganized distribution (Fig 2C). Primary bone matrix deposition does not follow a plan of absorption and distribution of forces, it only meets a demand for filling the injured area.

The granulation tissue extends for the inner part of neighboring medullary spaces, as well as for subperiosteal spaces lateral to the fracture line in such a way that it significantly overlays the surface and the contour of the original bone (Fig 2A, 2B). The excess bone formed from exuberant granulation tissue at the fracture line and which exceeds normal limits and dimensions is known as bone callus.

As the days goes by, primary or immature bone is filled with irregular trabeculae from the outer layer to the center, and is gradually reabsorbed. The areas it used to occupy will be then filled with secondary or mature bone which is able to meet functional demands, such as muscular forces exerted during movement (Fig 2D). As the weeks go by, the entire granulation tissue is replaced by a new secondary bone which is usually excessive. As the bone

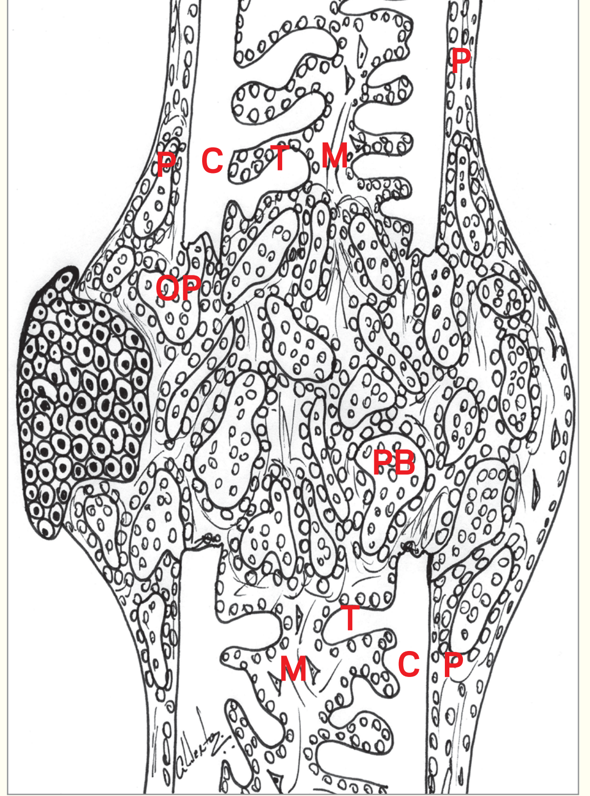
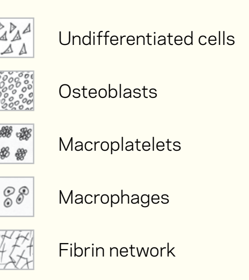


Figure 2C. Irregular primary bone (PB) trabeculae gradually occupy most granulation tissue, from the outer layer to the center. They are rich in cells and little mineralized due to exerting its filling function. In the subperiosteal areas, primary bone is also exuberantly formed, similarly to ossifying reactional periostitis. The temporary plug formed by hyaline cartilage gradually loses its function as the periosteum restores its continuity.
PB = primary bone; C = cortex; T = trabeculae; P = periosteum; M = bone marrow.



meets the functional demands to which it is subjected, it is continuously remodeled and adapted to its new conditions in accordance with its trabecular density. As a result, cortical thickness and bone callus gradually disappear.

THE ROLE OF THE PERIOSTEUM IN BONE FRACTURE AND THE ROLE OF MEMBRANES IN BONE REPAIR

Within a few hours after bone fracture is caused, the periosteum — acting as a specialized, membranous connective tissue — proliferates and tends to recover the injured or ruptured area, compartmentalizing the bone environment and restricting the repair process to the cells and bone structural components.

The injured or ruptured periosteum soon recovers in terms of continuity, given that one of its major functions within bone pathophysiology is to isolate the bone environment from neighboring soft tissues. Regarding the speed of migration, the cells of neighboring connective tissue are much faster than osteoblasts and predecessor cells. The presence of periosteum compartmentalizes the bone environment.

In bone fracture, it is common to find areas of hyaline cartilage (Fig 2B, 2C, 3)

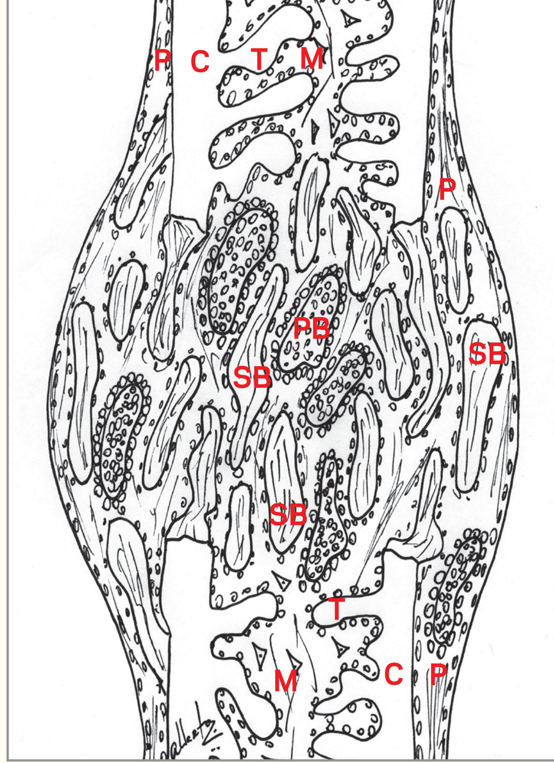
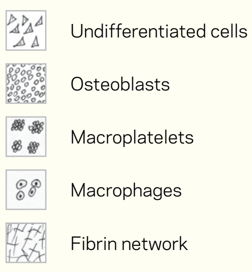


Figure 2D. Secondary or mature bone (SB) gradually replaces primary bone (PB) from the outer layer to the center. Due to being thicker and less cellularized than primary bone, it is able to meet functional and mechanical demands. The periosteum (P) restores its integrity and, as a result of frequent bone remodeling, the cortex (C) gradually recovers and excess bone formed on the surface (bone callus) is slowly remodeled. SB = secondary bone; PB = primary bone; P = periosteum; C = cortex; T = trabeculae; M = bone marrow.



usually where the periosteum was ruptured or severely injured. When the outer cells of bone repair granulation tissue are exposed to soft tissues, they differentiate into chondrocytes with a view to isolating the bone cavity, given that the periosteum is injured. After the periosteum is structurally recovered and bone repair gradually progresses, the hyaline cartilage ossifies or causes its cells to undergo a process of apoptosis, which replaces it by new bone.

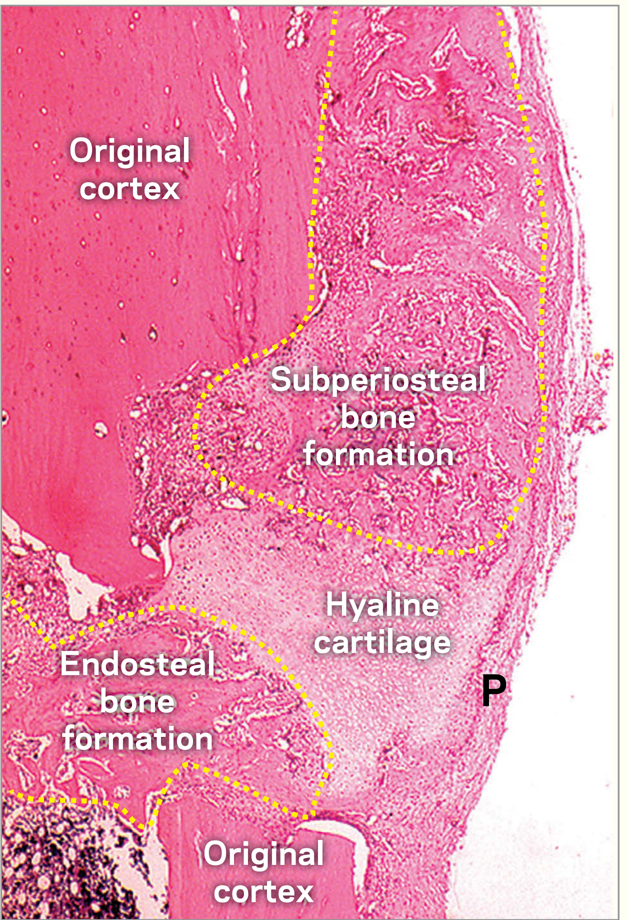


Figure 3. Bone repair process established in case of fracture, in which primary bone neoformation is well advanced in the subperiosteal and endosteal areas. The plug formed by hyaline cartilage and the covering of the area by the new periosteum (P) are highlighted. (HE, 10x).

The hyaline cartilage plays an effective role in areas of endochondral ossification. In areas of intramembranous ossification, as it is the case of the maxilla and mandible, the hyaline cartilage does not act because the cells that enter the granulation tissue do not have active genetic information that enables them to differentiate into chondroblasts (Figs 4,5). Thus, in these cases, the bone fracture site is more susceptible to be invaded by neighboring fibrous connective tissues, if the periosteum is severely injured or missing. Should the aforementioned situation occur in cases of movable bone fracture, a pseudarthrosis (false joint) is established.

When fibroblast cells invade the granulation tissue in areas of bone repair, there will be deposition of extracellular matrix typical of fibrous connective tissue. In other words, fibrous connective tissue will form (Figs 6, 7). The process by which fibrous connective tissue fills a space that does not exist under normal conditions is known as fibrosis or healing fibrosis. Fibrosis is common in cases of maxillary bone repair surgery and tooth extraction.

MEMBRANES USED AS PERIOSTEUM SUBSTITUTES IN SURGICAL BONE CAVITY

In the maxilla and the mandible, intramembranous ossification hinders the formation of hyaline cartilage which, at least temporarily, replaces severely injured periosteum (Figs 6, 7).

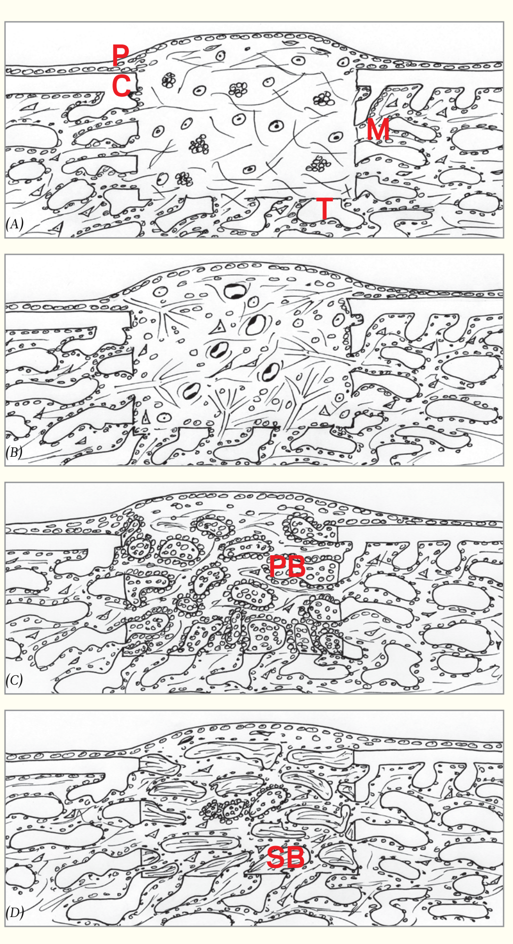


Figure 4. A) At the fracture site, the inflammatory exudate and blood clot are characterized by an exuberant fibrin network that provides anchorage to cells and platelets. **B**) Vessels and cells originating from the endosteum, bone marrow (M) and periosteum (P). The periosteum protects the granulation tissue from being invaded by neighboring fibroblasts that originate from fibrous connective tissue. **C)** Young osteoblasts migration favors synthesis of primary bone (PB) trabeculae which is irregularly distributed for space filling from the outer layer to the center. **D)** Subsequently, primary bone is gradually replaced, from the outer layer to the center, by secondary bone (SB) trabeculae which is more organized, less cellularized and more mineralized than primary bone, thus allowing it to meet functional and mechanical demands.
M = bone marrow; P = periosteum; PB = primary bone; SB = seconday bone; C = cortex; T = trabeculae.

Undifferentiated cells

Osteoblasts

Macropletelets

Hyaline cartilage

Macrophages

Fibrin network

Neoformed vessels

Primary or immature bone

Secondary or mature bone

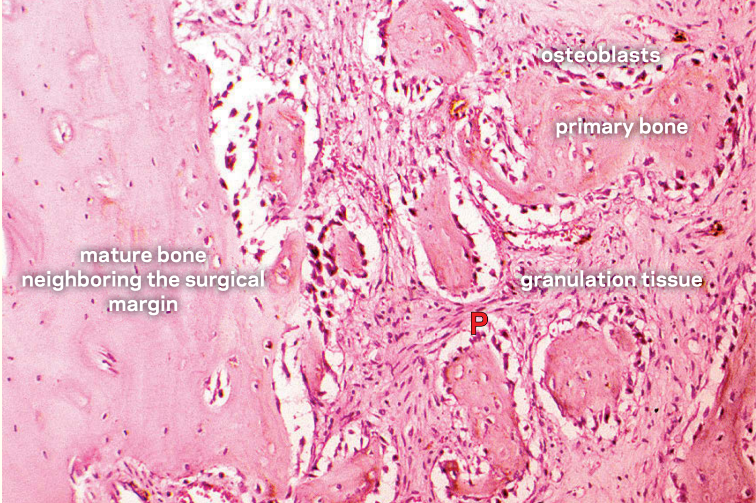


Figure 5. Primary or immature bone formation in granulation tissue of surgical bone cavity undergoing repair (HE, 25x).

For this reason, in cases of oral and maxillofacial surgery, it is recommended that special attention be given to the periosteum, particularly with regards to blood supply, flap surgery planning, irrigation during procedures to avoid cell desiccation and death, excess manipulation and evaluation during flap reposition. Cases of intramembranous ossification bone surgery with severely injured periosteum require a periosteum substitute[2] usually known as "membranes", epithelial regeneration guides or repair guides (Fig 8).

The membranes essentially aim at replacing injured or missing periosteum. A few days or weeks after the membrane is placed, the neighboring periosteum forms again by means of repair.[2] Resorbable or phagocytable membranes tend to practically restore the original characteristics of the site (Fig 8). Non-resorbable membranes, however, tend to remain at the site for an indefinite period of time, behaving as foreign body enclosed by macrophage and multinucleated giant cells of inflammation thata re convered by delicate connective tissue (Fig 8C). For this reason, it is recommended that this type of membrane be removed by means of a second surgical procedure, which may be inconvenient for the patient.

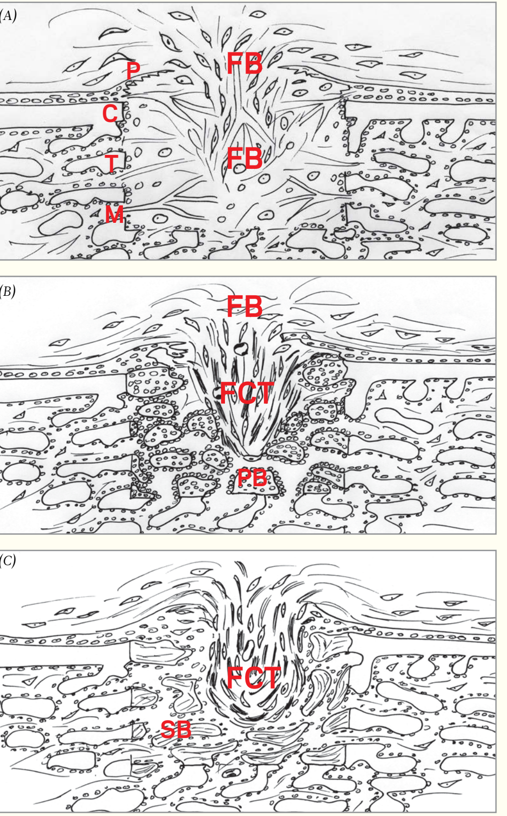
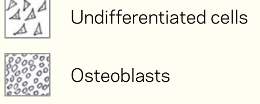
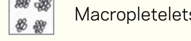


Figure 6. A) Severely injured periosteum (P) allows fibroblast cells (FB) from neighboring tissues to infiltrate into blood clot and exudate of the surgical cavity as a result of stimuli produced by repair mediators released by the macrophages and platelets. **B**) At this site, fibrous connective tissue (FCT) forms, in which case it will be known as healing fibrosis that hinders primary and secondary ossification in the surgical cavity. **C**) The surgical cavity remains with a structural and imaginologic defect. P = periosteum; FB = fibroblast cells; FCT = fibrous connective tissue; C = cortex; T = trabeculae; M = bone marrow; PB = primary bone; secondary bone.

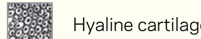
Undifferentiated cells



Osteoblasts

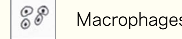


Macropletelets

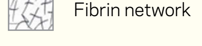


Hyaline cartilage

Macrophages

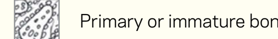


Fibrin network



Neoformed vessels

Primary or immature bone



Secondary or mature bone

The membranes that function as periosteum substitutes present some characteristics that are inherent to periosteum, namely: being permeable to ions, amino acids and peptides, as well as to mediators such as cytokines, growth factors and products of arachidonic acid. Furthermore, they must be permeable to medication molecules such as antibiotic, analgesic and anti—inflammatory drugs. Their degree of permeability must prevent the passage of the cells, only; allowing nutrients and cell mediators to flow.

When the membranes are contaminated by *staphylococcus* or *streptococcus* bacteria, they are associated with a suppurative inflammatory process with pus formation. Moreover, their porous structure requires increased care to prevent bacterial contamination before and during the surgical procedures. Likewise, knowing the origin of the product and avowedly knowing that it has been safely sterilized is key to achieve success with the surgical procedure.

In cases that require bone surgery, the periosteum, as well as its membranous substitutes, are anchored in the fibrin network of the inflammatory exudate and/or in the blood clot. The anchorage network offered

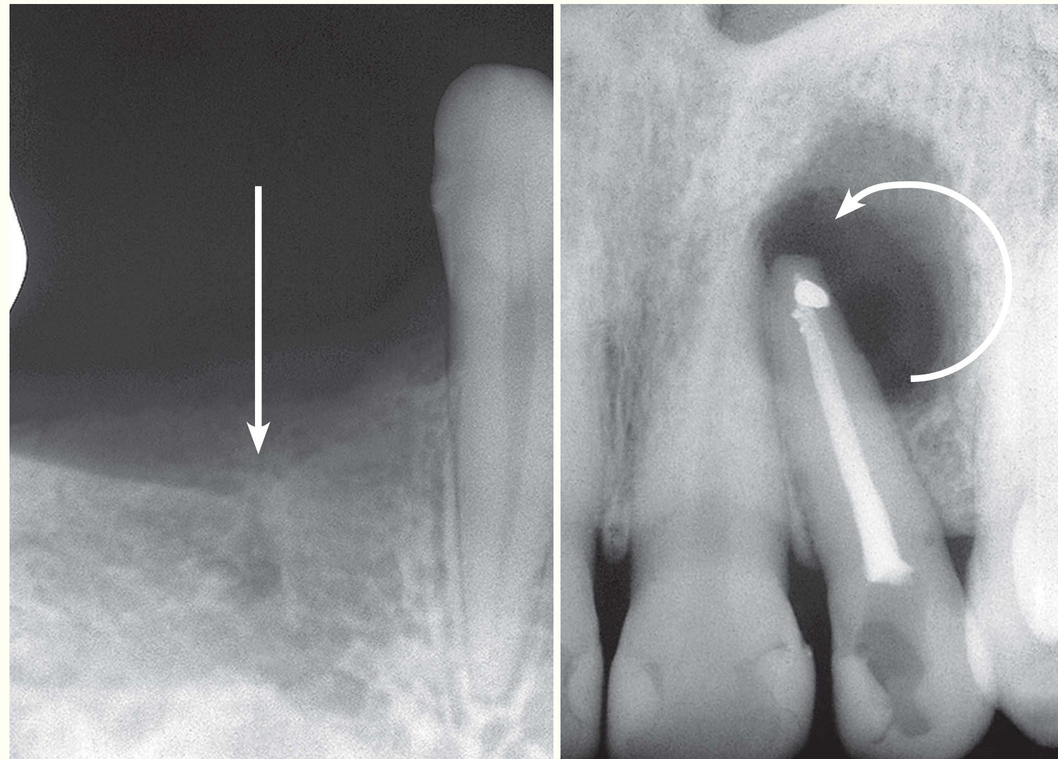
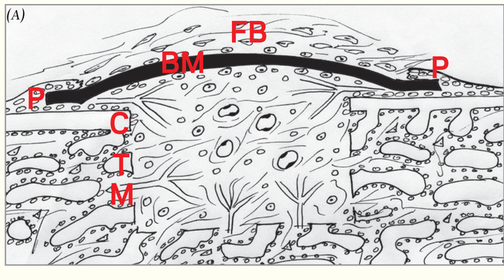


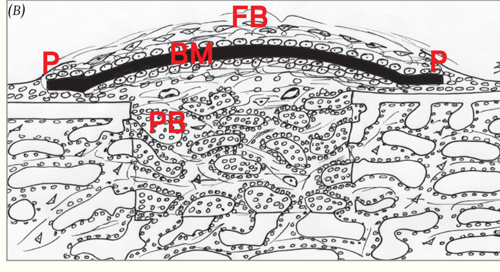
Figure 7. Fibrous connective tissue formation at two surgical sites as a result of severe periosteum defects not previously detected during flap reposition. Injured areas allowed infiltration of neighboring, soft tissue cells and formation of healing fibrosis.

by fibrin has some physical limitations, however, in cases of wider surgical cavities, the periosteum or its substitutes (the membranes) tend to mechanically break and retract. Therefore, a hollow is formed on the surface which is also followed by the periosteum and the membranes. During the final phase of repair, a portion of the surface bone cavity will not be filled by new bone, which implies in potential esthetic and functional complications.

In cases of wider surgical cavities, the fibrin network requires support for its mechanical anchorage, which may be provided by biomaterial, such as polymer fragments and lyophilized bone, placed within the cavity. It is worth noting that the use of membranes is not necessarily related to the use of biomaterial in bone repair. Nevertheless, membranes and biomaterial may be used together, as they exert different functions in bone repair.

Some cavities have a low or missing bone wall. In order to contain blood clot — the primary matrix of bone repair — within the cavity, bone walls and, occasionally, a membrane that not only functions as periosteum substitute, but also as a delimiting support to retain the blood clot formed within this type of cavity; are necessary. In other words, the membrane may sometimes be used to retain blood clot within a cavity.





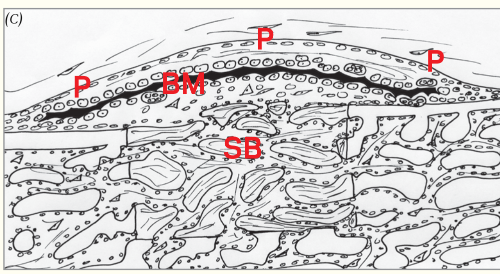
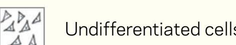


Figure 8. A) The use of a barrier membrane (BM) as a periosteum (P) substitute prevents fibroblast cells (FB) from neighboring tissues to infiltrate into blood clot and exudate of the surgical cavity as a result of stimuli produced by repair mediators released by the macrophages and platelets. **B**) When a resorbable membrane is used, a foreign body-type granuloma will temporarily form and the macrophages will gradually phagocytize the membrane. **C**) Meanwhile, the periosteum recovers itself over the degrading membrane, which may last for weeks or months. BM = membrane; P = periosteum; FB = fibroblast cells; C = cortex; T = trabeculae; M = bone marrow; PB = primary bone; SB = secondary bone.



Undifferentiated cells

Osteoblasts

Macropletelets

Hyaline cartilage

Macrophages

Fibrin network

Neoformed vessels

Primary or immature bone

Secondary or mature bone

FINAL CONSIDERATIONS

1) *The periosteum is the delimiting structure that covers the bones and prevents the cells of neighboring soft tissues from infiltrating into the bone structure and, as a result, weakening it.*
2) *In cases of traumatic lesions caused by fracture ,surgery, and bone surgical cavities in which the periosteum is injured, the cells of soft tissues tend to infiltrate into the bone structure and form areas of fibrous connective tissue, also known as healing fibrosis. These areas do not ossify, but weaken the site and promote esthetic and/or functional defects.*
3) *The membranes, when properly used as periosteum substitutes, may function as a barrier that allows the blood clot and the inflammatory exudate to be colonized by cells of osteogenic lineage.*

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literature review

Connection between periodontal disease and chronic kidney disease: A literature review

Abstract / Introduction: *The association between periodontal disease (PD) and chronic kidney disease (CKD) is bidirectional, as individuals with CKD may have oral manifestations, and PD may develop as a complicating factor of CKD. The systemic inflammatory response found in periodontal patients may have a synergistic effect on the chronic inflammation found in CKD.* **Objective:** *To review the literature to find evidence of the importance of the association between these two conditions.* **Methods:** *A PubMed search of studies published between 2003 and 2013 was conducted to retrieve clinical trials and systematic reviews.* **Results:** *Six clinical trials and one systematic review met the established criteria. Clinical trials used different approaches for the association between PD and CKD. Studies investigating the association between PD and CKD used a crossover design, evaluation of the oral manifestations in patients with CKD, and analysis of the effect of periodontal treatment on markers of renal disease.* **Conclusion:** *In addition to systemic functions, CKD also affects oral health, particularly causing periodontal tissues. Moreover, PD may affect kidney functions and lead to complications in individuals with CKD.*
Keywords: *Chronic renal insufficiency. Periodontitis. Renal dialysis.*

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INTRODUCTION

Chronic kidney disease (CKD) is a progressive condition characterized by renal failure.[1]

Structural changes result from certain diseases, usually underlying pathologies, such as diabetes, hypertension and glomerulonephritis, that lead to loss of renal function.[1] As kidneys adapt to loss of function, important signs of failure are only detected at advanced stages of the disease.[2]

Patients with CKD may present several oral manifestations, such as dry mouth, uremic stomatitis, X-ray detected maxillary and mandibular abnormalities secondary to calcium loss due to the increase of parathyroid hormone, dental calculus due to higher serum calcium and phosphorus concentrations, high concentration of urea in saliva, abnormal bone remodeling after extraction, delayed tooth eruption, tooth mobility, malocclusion, and sensitivity to percussion and mastication, as well as a high prevalence of periodontal disease (PD).[3]

The association between PD and CKD is bidirectional, as individuals with CKD may have oral manifestations due to CKD, and PD may become a complicating factor of CKD. The systemic inflammatory response in patients with PD may have a synergistic effect on the chronic inflammation found in CKD.

Therefore, considering the severity of CKD, the high prevalence of PD and the importance of PD for the health of individuals with CKD, this study reviewed the literature to find evidence that may demonstrate the relevance of the association between CKD and PD.

MATERIAL AND METHODS

A literature review was conducted using PubMed to retrieve studies published between 2003 and 2013. Clinical studies and systematic literature reviews were selected. The keywords used were renal disease, kidney disease and periodontitis. The title and abstract of the studies retrieved were evaluated to define whether they met the following inclusion criteria:

» Evaluation of PD and CKD according to their incidence, prevalence and bidirectional association;
» Patients undergoing renal dialysis;
» Controlled clinical trials and systematic reviews;
» Publication between 2003 and 2013;
» Texts in English or Portuguese.

RESULTS

Twenty studies were retrieved; 11 were excluded after their title and abstract were read because they did not deal with the topic of this study or were not systematic reviews. Of the nine studies included in this review, three are systematic reviews and six are controlled clinical trials.

The clinical trials used different approaches to the analyze the association between PD and CKD, such as the use of a crossover design to search for an association between PD and CKD, the investigation of oral manifestations in patients with CKD, and the evaluation of the effect of periodontal treatment on CKD.[4-9]

Kshirsagar et al[4] investigated the association between PD and CKD by using a sample of 5537 individuals that underwent examination of their periodontal health and renal function. Initial (odds ratio = 2.00) and severe (odds ratio = 2.14) PD were associated with low glomerular filtration rates and elevated serum creatinine levels.

Dias et al[6] evaluated the oral health of patients with CKD who underwent

hemodialysis. One hundred and seven patients were divided into three groups according to the time that they had been on hemodialysis (3 months to 1 year; 1 to 3 years; more than 3 years) and evaluated according to their plaque and caries index. The authors found that the time of disease treatment did not affect or change bacterial film accumulation or the prevalence of caries.

Bayraktar et al[5] studied the oral health and presence of inflammation in patients with end-stage renal failure and found that the patients with CKD had worse periodontal and dental health than the controls. This finding may play an important role in systemic inflammation among these patients.

Graziani et al[9] assessed the effect of periodontal treatment on glomerular filtration rate of 20 systemically healthy patients. Their results revealed that periodontal treatment improves the concentration of cystatin C, a glomerular filtration marker. They found that periodontal treatment may affect glomerular filtration, and suggested that further studies be conducted to confirm their findings.

Vilela et al[8] studied the impact of periodontal treatment on serum prohepcidin levels and systemic inflammatory markers in patients with CKD not undergoing dialysis. Thirty-six patients with CKD and 20 systemically healthy controls received periodontal treatment. The levels of C-reactive protein, IL-6 and prohepcidin were lower in both groups, which confirmed that periodontal treatment is an important intervention to reduce inflammation in patients with CKD.

Wehmeyer et al[7] assessed the result of intensive periodontal treatment on metabolic and inflammatory markers of 53 patients with CKD undergoing dialysis. Their results did not show any improvements in serum albumin and IL-6 concentrations after 6 months of treatment. However, the authors suggested that studies with a larger number of patients might validate their findings.

The systematic reviews included in this study found that there is consistent evidence to support the existence of a positive association between periodontitis and CKD, as well as of a positive effect of periodontal treatment on glomerular filtration rates.[10]

DISCUSSION

PD may interact with other conditions that affect the human body. Several risk factors that make individuals susceptible to PD and accelerate its progression may also be found in patients with CKD, such as immunodeficiency, diabetes, smoking, deficient oral hygiene, dry mouth and poor nutrition. Several study findings support the hypothesis that individuals with PD also have a high risk of CKD, even after statistical adjustment to other independent risk factors.[10]

Some studies demonstrate that the incidence and severity of periodontitis are greater in patients with CKD than in the population in general.[3, 11-15] Evidence also suggests that the type of renal disease treatment may affect PD severity and extension. This disease is usually more advanced in patients undergoing hemodialysis, and is less severe in patients undergoing continuous ambulatory peritoneal dialysis or predialysis.[13,14]

The association between PD and CKD is bidirectional, in other words, uremia contributes to the increase of gingival inflammation in patients undergoing dialysis, and the systemic inflammatory response in patients with PD may have a synergistic effect on the chronic inflammation found in CKD.[11]

Individuals with initial or severe PD are more likely to have loss of renal function than individuals with a healthy periodontium or with gingivitis.v Additionally, these patients may have a low glomerular filtration rate and a high serum creatinine concentration.[4,16] Some studies found an association between subgingival infection by *Porphyromonas gingivalis* and systemic inflammation indicated by elevated C-reactive protein levels in patients with PD undergoing dialysis.[17,18,19]

In addition to PD, individuals with CKD also have a low salivary flow rate[5] and a high index of missing or filled teeth.[6]

CKD affects the human body because it changes its systemic functions. One third of the population of patients with CKD have suppressed cell and humoral immune responses, as well as serum IgA, IgM and IgG concentrations below normal levels. Studies of salivary IgA in patients with PD and healthy individuals showed that there are differences that may be used to detect groups with a high risk of PD.[20,21]

The acute phase response is triggered after infection, and the purpose of this reaction is to remove the aggressive agent and promote cure. Effects of the acute phase response are mostly unspecific, in contrast with cell or humoral immunity.[17]

If PD increases systemic inflammation and the risks for patients with CKD, periodontal treatment should be able to reduce systemic levels of inflammation.[7,8,10] D'Aiuto et al[22] suggested that periodontal treatment may lead to a decrease in inflammatory markers, a consequent reduction in the levels of C-reactive protein, IL-6 and TNF-α and a partial restoration of endothelial functions. Moreover, Graziani et al[9] found that periodontal treatment may reduce cystatin C, an important marker of glomerular filtration levels.

CONCLUSION

CKD affects the systemic functions as well as the oral health of patients with this disease, particularly their periodontal tissues. Moreover, PD may also affect patients' renal function and lead to further complications. Therefore, it seems to be plausible that these two diseases have a bidirectional association, but further studies should be conducted to confirm such association.

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Recovering function and aesthetics of a fractured tooth using the immediate dentoalveolar restoration technique: Case report with a 3-year follow-up

Abstract: *The prognoses of root fracture, endodontic failure or advanced periodontal disease are not favorable. The treatment of choice for such patients includes removal of the tooth and implant therapy. Root fracture is commonly associated with bone loss, especially in the buccal wall, and the aesthetic risk is increased. This article describes the use of the Immediate Dentoalveolar Restoration technique to restore a compromised socket through bone graft, implant placement and immediate function in a patient with a complicated crown-root fracture in the maxillary central incisor. The patient was followed up clinically and tomographically for 3 years.* **Keywords:** *Dental implant. Fresh socket. Bone graft. Immediate loading.*

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

INTRODUCTION

Root fracture, endodontic failure, and advanced periodontal disease are frequently associated with tooth extraction and immediate implant placement. The extraction delay of a fractured tooth can lead to bacterial biofilm development, and bacterial spread into or from the fracture space,[1,2] resulting in buccal bone loss.[3] Traditionally, immediate implant placement has been contraindicated in the presence of active infection and bone defects,[4] especially in the absence of buccal bone wall.[5] Therefore, to improve clinical efficacy and esthetics and to reduce treatment time, the Immediate Dentoalveolar Restoration (IDR) technique was developed.

The aim of IDR is to restore the buccal bone wall during implant placement. To correct socket defects and support soft tissue esthetics, the buccal bone wall is reestablished with cortico-cancellous bone graft from the maxillary tuberosity. This technique has its limitations, for example, it requires adequate bone availability in the tuberosity. This paper reports the 3-year follow-up outcomes of a patient with vertical root fracture (VRF) in the region of the upper central incisor. Preoperatively, the patient presented socket damage and acute infection, and was treated by the IDR protocol which consists in tooth extraction, implant placement, bone graft and immediate provisional crown installation, thereby enabling treatment to be carried out in a single procedure.

CASE REPORT

A 50-year-old woman was referred for treatment of painful symptoms in the maxillary left central incisor. Clinically, the gingival tissue exhibited fibrosis and scars at the surgical site, a thin periodontal biotype, swelling, and fistula in the vestibular region (Fig 1A). The probing depth was 11 mm buccally (Fig 1B). Cone beam computed tomography (CBCT) images showed a metallic core, good bone availability beyond the root apex, and buccal bone wall loss (Fig 1C). Due to the local infection in the fractured root (Fig 2A), antibiotic therapy started 5 days prior to and continued for 7 days after surgery.

A minimally invasive dental extraction procedure was performed. The socket was carefully treated by curettage to remove the granulation tissue and the remaining

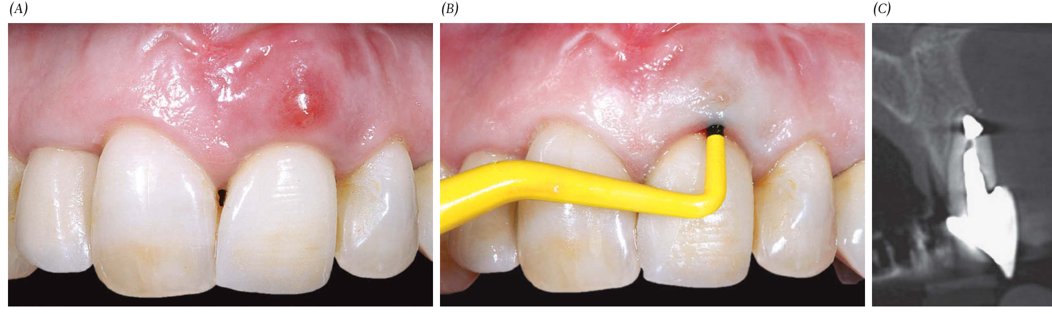
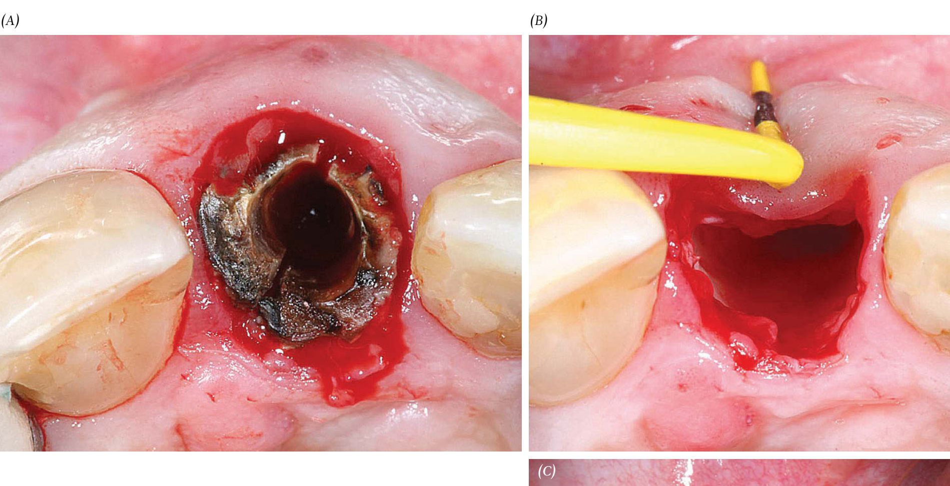


Figure 1. Initial clinical assessment of the compromised tooth #9 with fistula (**A**, **B**). The absence of the buccal bone wall is visible on the CBCT image (**C**).

periodontal connective tissue. The socket walls were probed in the apical-coronal and mesial-distal directions to assess the degree of bone damage and to verify the anatomical shape of the defect (Fig 2B, C). An implant (13 mm in length and 4.8 mm in diameter) was installed with a palatal approach and anchored into the bone beyond the root apex, resulting in a stability of 50 Ncm (Fig 3A). A provisional crown was constructed, establishing an ideal emergence profile to allow accommodation of the soft tissue (Fig 3B, C).[6]

After anesthesia at the donor area was achieved, a crestal incision was made in the maxillary tuberosity. An appropriate gouge-shaped chisel, 2 mm wider than the width of the bone defect (Fig 4A and B), was selected to harvest the graft according to the shape of the region to be restored (Fig 4C). Manipulation of the cortico-cancellous graft from the maxillary tuberosity was carried out using a rongeur to reproduce the shape of the peri-implant bone defect (Fig 5A). The cortico-cancellous bone graft was positioned approximately 1 mm from the implant platform, coronally, juxtaposed to the edges of the bone defect (Fig 5B), achieving primary stabilization of the graft, with the cortex turned toward the soft tissues. Subsequently, particulate



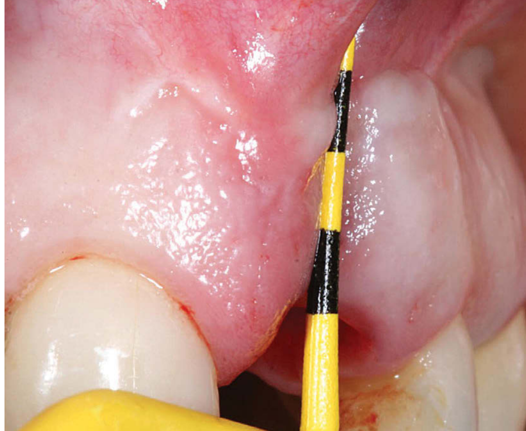
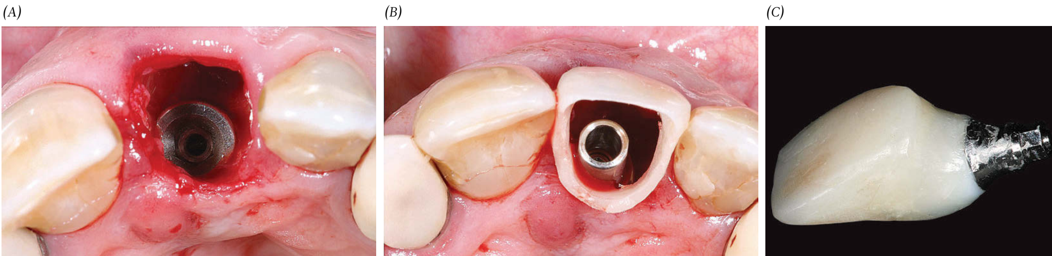


Figure 2. Clinical evaluation of the vertical root fracture (**A**) and the extent of bone loss in the apical and mesiodistal directions (**B**, **C**).



Figue 3. Implant placement (**A**) and construction of a provisional crown before the grafting procedure (**B, C**).

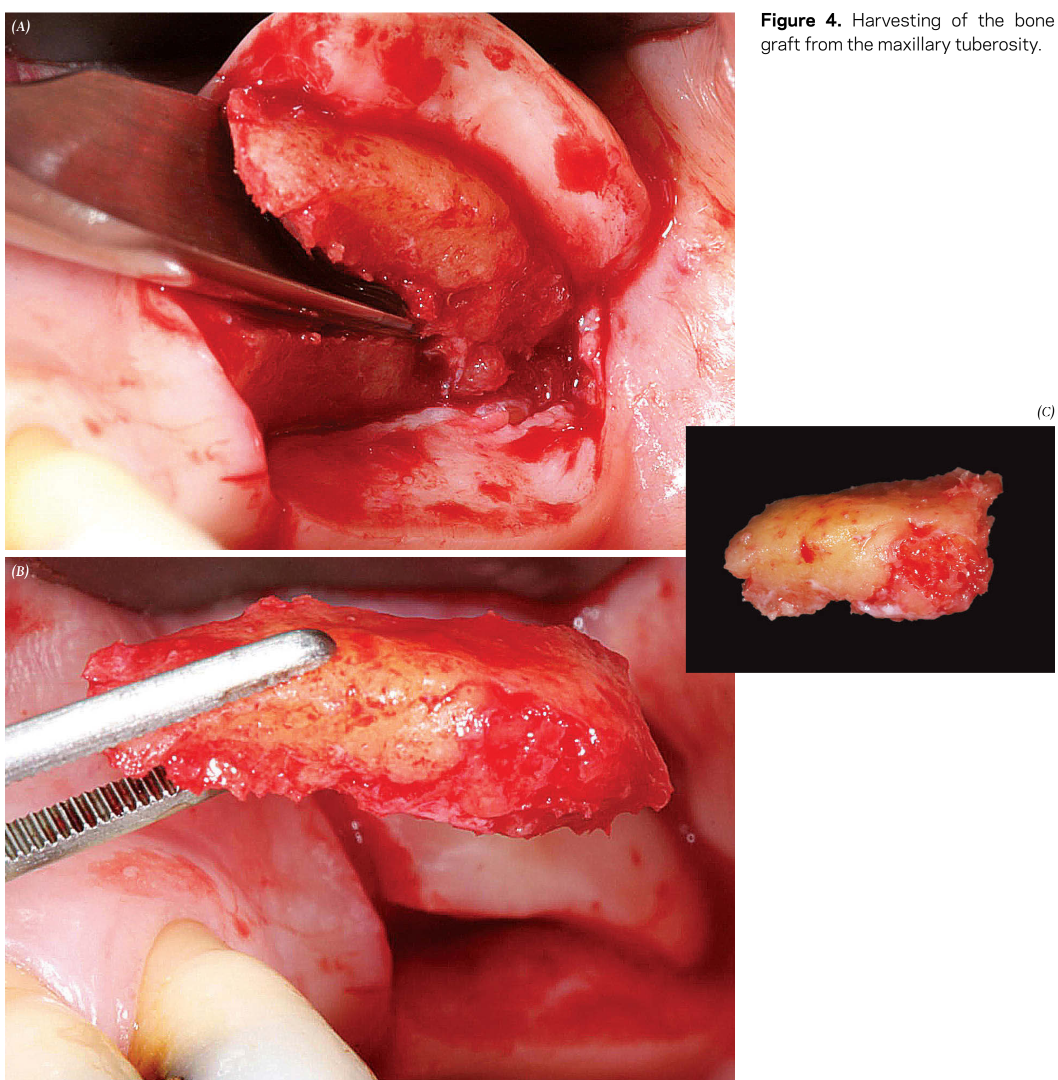


Figure 4. Harvesting of the bone graft from the maxillary tuberosity.

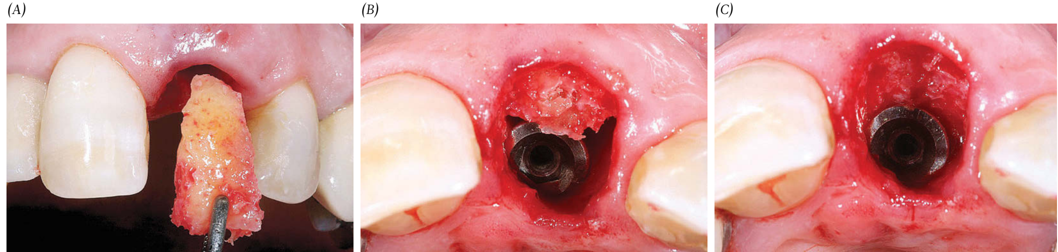


Figure 5. Insertion of the cortico-cancellous graft, with the cortex on the buccal side (**A**) to the level of 1 mm from the implant platform, coronally (**B**). Final stabilization of the bone graft by filling with particulate medullary bone between the buccal surface of the implant and the internal portion of the bone graft (**C**).

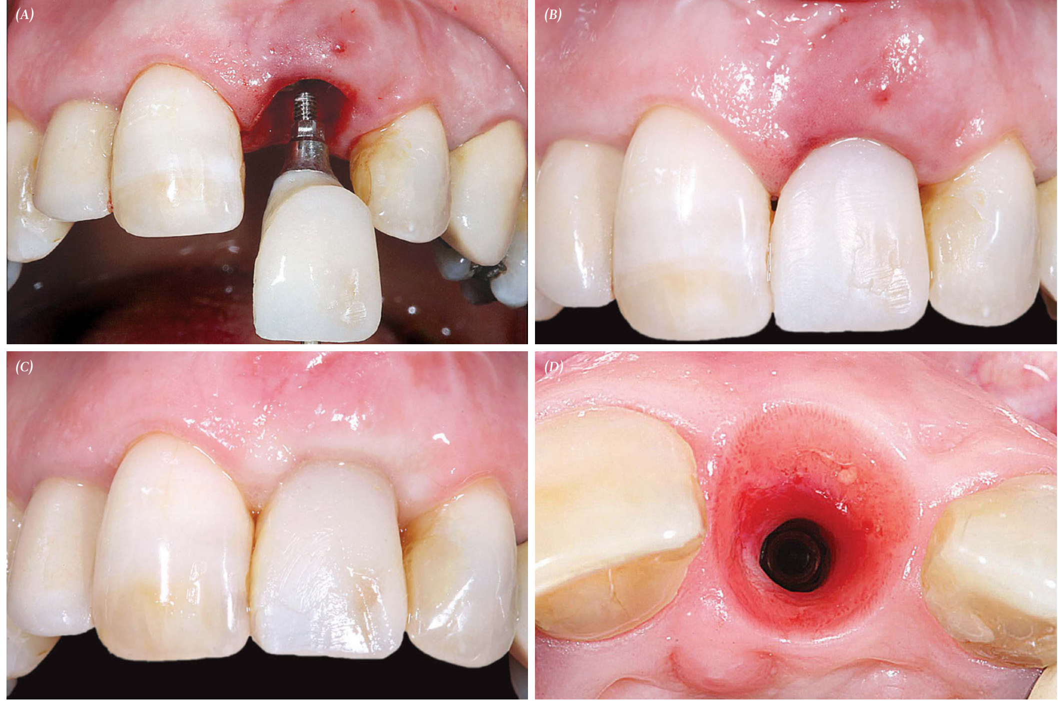


Figure 6. Installation of the provisional crown (**A**, **B**). The results 4 months following the procedure, and after adding composite resin at the cervical portion of the provisional crown to balance the gingival margin, achieving good quality and volume of soft tissue (**C**, **D**).

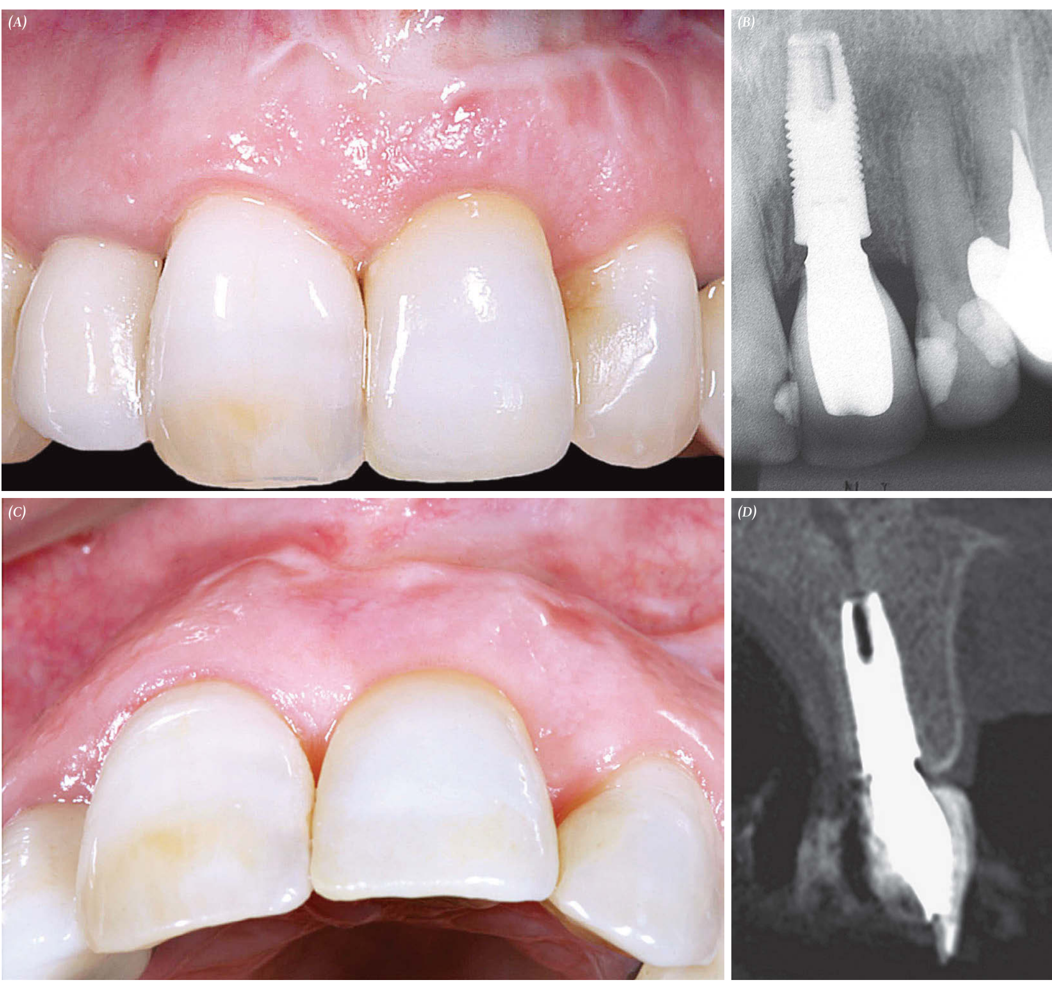


Figure 7. Clinical assessment 3 years after the operation, showing stabilization of the soft tissues (**A**, **C**). Radiographic aspect showing the stability of the mesial and distal bone (**B**). Tomographic slice showing restoration of the buccal bone wall, that remains stable after total remodeling 1 mm from the implant platform, coronally (**D**).

bone marrow was inserted and packed between the medullary portion of the cortico-cancellous graft and the surface of the implant to ensure secondary stabilization of the graft (Fig 5C). Finally, the provisional crown was installed to seal the gingival margin (Fig 6A and B) and to provide final stabilization of the bone graft.

The patient was monitored clinically every week for the first month and every month for the next 4 months thereafter. After this period, composite resin was added at the cervical portion of the provisional crown (Fig 6C). Once bone and gingival architecture were reestablished (Fig 6D), a careful impression was obtained to capture the emergence profile. A zirconia abutment was installed using a torque of 35 Ncm. A lithium disilicate dental crown was constructed. After testing the porcelain and performing esthetic and functional adjustments, the crown was fixed with adhesive cement. Three years later, the clinical, radiographic and CBCT images show stability of hard and soft tissues (Fig 7).

DISCUSSION

The reported prevalence of VRFs in the literature ranges from 10.9% to 12.9%.[7] Posts in the root canal are associated with 61.7% of root fractures.[8] The prognosis of a tooth with extensive fracture is poor, and in most situations, extraction is the only possible treatment option. VRF is usually associated with acute infection and damage of the socket, followed by bacterial biofilm development in the fracture space. In a clinical retrospective study of 75 patients, only 32% of extraction sites had intact bone walls, and 68% presented damage to at least one wall.[9] The buccal bone wall is the most affected site because it is thinner and not as well vascularized.

The goal of the IDR technique is to promote a barrier with a cortico-cancellous graft, between the soft tissue and the particulate bone graft stabilized around the implant. The graft, which is harvested from the tuberosity, is modeled in the shape of the bone wall defect. IDR is an alternative to block grafting and guided bone regeneration procedures. It yields satisfactory functional and esthetic results, besides reducing total treatment time. This method enables recovery of the alveolar bone defect during the same surgical procedure of implant installation and immediate provisionalization. Although some studies[10,11] have voiced concerns regarding the adoption of immediate implant therapy in the presence of fractured or infected teeth because of possible biological complications, a systematic review found no differences in outcome with regard to the presence of infection.[4] To reduce the risks, the IDR uses a strict surgical protocol with careful curettage of the socket to remove the granulation tissue, and antibiotic therapy should start before implant placement.

The IDR technique is based on important biological principles. The trabecular nature of grafts harvested from the maxillary tuberosity suggests that such grafts have a high revascularization capacity and release growth factors to the receptor site.[12] However, these grafts must be transplanted rapidly to prevent the loss of their fundamental properties.[13,14]

Another important factor for the success of the IDR technique is the use of flapless surgery, which reduces the possibility of recession of the surrounding hard and soft tissues, commonly seen in more

invasive procedures. Flapless surgery has reportedly good esthetic results and low postoperative morbidity. However, it is a "blind" procedure, and the risk of complications increases when bone defects are larger.[15] For this reason, the clinical assessment and CBCT diagnostic imaging are fundamental to confirm the dimensions of bone defect to be reconstructed and the presence of adequate bone height at the anticipated site of implant placement.

Immediate implant placement after extraction can be successfully performed to reduce treatment time without reducing predictability with respect to standard protocols. Biological changes that occur when an implant is used at an early stage are of great importance in bone repair. Early low-intensity stimulation increases the local blood flow and contact osteogenesis, thereby accelerating the process of bone graft repair.[16]

In damaged sockets, soft tissue stability is necessary for reconstruction of the peri-implant tissue components. Absence of a buccal bone wall to support the facial mucosa may lead to recession and incomplete papillae.[2] Thus, implant treatment goals must be expanded to include the reconstruction of these lost anatomical structures. A goal of the IDR technique is to reestablish lost bone wall, thereby correcting socket defects and supporting soft tissue esthetics with bone graft from the maxillary tuberosity, at the same time of implant placement and provisional crown fabrication. However, the maxillary tuberosity also presents some disadvantages due to the limited quantity of bone available, low bone density, and difficulty of surgical access.[12]

Immediately after implant insertion and dentoalveolar restoration, coagulum and a fibrin network form and fill the remaining spaces between the implant and the grafted bone. If the gap is wide, there is a risk of ongoing resorption of the buccal bone wall and exposure of the implant surface. According to Buser and Martin,[17] if the width between the implant and the labial bone wall exceeds 2 mm, then a considerable amount of horizontal bone resorption can be expected, and simultaneous bone graft is necessary to promote bone regeneration. Based on this principle, also in the use of IDR, all alveolar spaces should be filled with particulate bone from the tuberosity.

CONCLUSION

Cortico-cancellous bone graft, manipulated according to the bone defect format, associated with particulate bone marrow from the maxillary tuberosity promotes restoration of freshly damaged sockets, thereby enabling immediate provisionalization of an implant, avoiding the need for several surgical procedures, and preventing the esthetic risks related to these procedures. The IDR technique, therefore, represents a viable and reproducible treatment alternative, since the protocol is followed accurately.

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Natural *versus* artificial: Comparative study of the root cementum and the nanotexturized surface of osseointegrated implants

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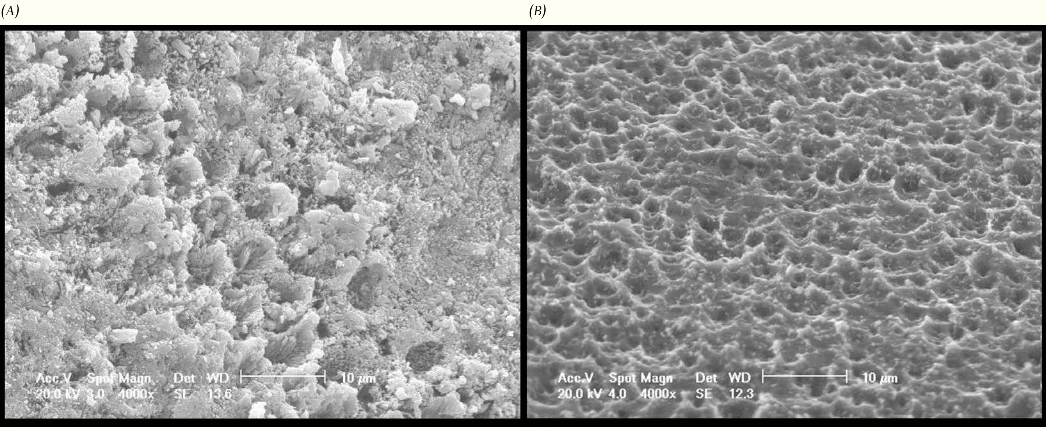
Comparison between two photomicrographs, obtained by scanning electron microscopy (under magnification of 4,000x), of the root surface of a tooth and the nanotexturized surface of an osseointegrated implant (NanoTite, BIOMET 3i). Note the strong similarity between the rugosity created by nature over the root cementum **(A)** and the texture of the implant surface **(B)**.



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literature review

A literature review on the clinical performance of fixed prostheses with tooth-implant connection

Abstract: *Dental implants are widely accepted in the Dentistry field. New restorative procedures, employed in edentulous patients with no prospect of satisfactory treatment, have been established on the basis of Implantodontics. Thus, not only patients, but also specialists have gained the benefits of the new procedures for oral rehabilitation. However, fixed prostheses in which natural teeth connect with osseointegrated implants are still an issue. Thus, this paper aimed at conducting a literature review on implant/tooth-supported fixed prostheses, taking into account the new procedures established for restoration of partially edentulous patients.*
Keywords: *Dental prosthesis. Dental implant. Treatment.*

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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.

INTRODUCTION

In 1986, Sullivan[10] discussed about the prosthetic considerations associated with the use of osseointegrated implants attached to natural teeth in fixed partial denture. Tooth immobility caused by the use of rigid connections was highlighted as a major concern, as it may lead to atrophic changes in the periodontal ligament, increased medullary spaces adjacent to the tooth and greater susceptibility to periodontal inflammation.

Weinberg and Kruger[11] analyzed the distribution of forces in tooth-supported as well as implant-supported prostheses and found significant differences between them. The authors suggest the use of non-rigid connections for combined implant/tooth-supported prostheses.

Fugazzotto et al[8] analyzed the results yielded with 843 patients treated with 1,206 implant/tooth-supported prostheses using 3,096 screw-fixed connections. According to the authors, several problems occur after different treatment approaches are employed to attach natural teeth to implants beneath fixed prostheses. After 3 to 14 years in function, only nine cases of intrusion were noted. All problems were associated with fractured or lost screws. This study demonstrates the efficacy of this treatment approach when tooth/implant-supported fixed prostheses are used. It revealed that the incidence and severity of natural teeth intrusion after fractured or lost screws relies on the variable of time. Whenever fractured or lost screws were observed within 3 months, tooth intrusion did not occur.

Brägger et al[12] compared the frequency of technical as well as biological complications between implant-supported fixed partial denture (FPD), tooth-supported fixed partial denture (tooth FPD) and implant/tooth-supported fixed partial denture (tooth-implant PPF) over 4 to 5 years of function. Group I (implant FPD) included 33 patients with 40 FPDs; group II (tooth FPD) included 40 patients with 58 FPDs; and group III (tooth-implant FPD) included 15 patients with 18 FPDs. Of the bridge abutments, 144 used teeth as abutment, while 105 used implants. The mean number of units replaced by FPD was three. Complete failure resulted in one FPD loss in each group. Two implants were lost due to fracture caused by bone defect. One tooth underwent vertical fracture and one was lost due to periodontitis. Biological complications (peri-implantitis) occurred in 9.6% of the implants.

Biological complications also occurred in 11.8% of teeth used as abutment: 2.8% had secondary caries; 4.9% had endodontic issues and 4.1% of teeth had periodontitis. Technical complications were associated with bruxism. The authors found favorable clinical conditions for implants and teeth used as abutments after 4 to 5 years of function. Within this period, FPD loss occurred at a similar rate with implant-supported, tooth-supported and implant/tooth-supported prostheses. More fractures were found in implant-supported FPD. Impaired general health status was not significantly associated with major biological failures; however, bruxism and prosthesis extensions were associated with major technical failures.

Lindh et al[13] conducted a longitudinal comparative study with 26 patients with residual anterior dentition who were bilaterally treated with two different designs of partial denture fixed in the posterior maxilla. On one side, the reconstruction

was implant-supported, whereas on the opposite side, implant/tooth-supported prostheses were used. Patients were monitored for 3, 6, 12 and 25 months after implant loading. Ninety-five implants were installed, eleven of which were not loaded. A total of ten implants failed, seven prior to loading and three within the first 3 months of function. The authors found no differences in failure rate for implants with two different prosthesis designs. The total mean loss of bone height near the implants was within acceptable standards, however, it was more severe for implants that were not combined with teeth. Results revealed a correlation between prosthesis design and marginal bone loss.

Naert et al[2] conducted a study with 123 patients in which 339 implants were connected to 313 teeth by means of fixed partial denture (experimental group) and monitored for 1.5 to 15 years; and with 123 patients in which 329 freestanding implant-supported prostheses were installed (control group) and monitored for 1.3 to 14.5 years. Their study aimed at comparing the treatment methods performed with implants. To this end, they assessed the implant, the tooth and the prosthesis-related complications. Implant success was assessed with respect to immobility and/or absence of fracture after loading. In the experimental and control group, it reached 95 and 98.5%, respectively. According to the authors, implant/tooth supported prostheses are more likely to present implant failure (immobility and fracture) and prosthetic complications. For this reason, the use of freestanding prosthesis is a primary option that should be considered. In order to prevent intrusion of the abutment tooth, the connection must be completely rigid.

Lindh et al[24] conducted a retrospective study about implants attached to natural teeth. They aimed at assessing implant survival rate, marginal bone loss and the indications of this treatment approach. Their study comprised 111 patients selected at different clinics in Sweden who received 185 implants.

The authors found out that the implant survival rate was 95.4% after a three-year follow-up. All cases revealed intrusion for restorations with non-rigid connections between implants and teeth.

Block et al[14] conducted a clinical prospective study and assessed the effect of rigid and/or non-rigid connections over teeth and implants in a cross-arch model. Thirty patients received two implants, one on each side of the mandibular arch, and underwent restorative treatment with three fixed partial dentures connected with rigid or non-rigid abutment tooth. Repeated-measures analysis did not reveal significant differences in bone loss for implants (rigid versus non-rigid). The percentage of patients who presented measurable intrusion was 66% for the non-rigid group and 44% for the rigid group; 25% of non-rigid teeth presented intrusion greater than 0.5 mm, in comparison to 12.5% for the rigid group. The authors concluded that the high incidence of intrusion and non-scheduled patient visits suggest that alternative treatments without implant/tooth connections may be indicated.

Zhiyong et al[15] highlighted the influence of prosthesis design and loading condition over stress distribution on implant/tooth-supported prostheses. Six 2D finite element models, two reference models and four experimental models were digitized with a view to simulating different prosthesis

designs. Six different loadings conditions were applied to assess the stress distribution on teeth and implants. This study revealed that the loading on implant/tooth-supported prostheses was mainly supported by the implant. Minimizing the loading on the tooth decreased the stress exerted over the tooth and the implant. Using implants as abutment was more effective in minimizing the stress than using teeth as abutment in implant/tooth-supported prostheses.

Lin, Wang and Kuo[9] assessed the biomechanics in an implant/tooth-supported system submitted to different occlusal forces, with rigid and non-rigid connections by adopting a non-linear 3D finite element approach. The authors concluded that: (I) Contact elements may be carried out to simulate the realistic interface condition within the implant system and the sliding keyway function; (II) Both occlusal contact force and contact position affect the distribution of stress in a splinting system with different connection designs; (III) The stress-breaker function is only clear when occlusal forces act on natural teeth; (IV) Occlusal adjustment procedures can reduce the effect produced by the cantilever and redistribute stress in the maximal intercuspation or lateral working position for implant/tooth supported prostheses.

Ormianer et al[16] conducted an *in vivo* study to measure strains involved in connecting implants to a natural tooth and compared rigid and nonrigid tooth/implant connections.

Strain gauges were cemented to the experimental restoration, and recordings were obtained from the restorations while the patient bit on a wooden stick on the day of placement and after 2 weeks in function, using both rigid and non-rigid attachment connections.

According to the authors, and within the limitations of this study, combined implant/tooth-supported restorations could be a potential complication and could cause intrusion of natural teeth, regardless of the type of connection.

Lin et al,[25] using a non-linear finite element approach, investigated the mechanical interactions established between combined implant/tooth systems with different periodontal support and number of teeth connected to rigid and non-rigid connectors. The authors concluded that the finite element analysis suggests that non-rigid connectors be carefully used, as they break stress transference and increase unfavorable stress values in the implant system. The implant/tooth—supported system with additional splinting exerts its function in a more efficient way with impaired periodontal support.

Nickenig, Schäfer and Spiekermann[17] reviewed the incidence of biological and technical complications in cases of implant/tooth—supported fixed partial dentures (FPD) treatments. Based on the treatment documentations of a Bundeswehr dental clinic (Cologne-Wahn German Air Force Garrison), the medical records of 83 patients with implant/tooth—supported prostheses were recorded. The median follow-up time was 4.73 years. According to the authors, technical complications of implant-supported FPD depend on the different prosthesis configurations. The use of rigid functional connections yields similar favorable values as in case of solely implant-supported FPDs.

Krennmair et al[18] conducted a retrospective study to assess the results of implants and natural teeth used as combined abutments to support maxillary telescopic prostheses. Between 1997 and 2004,

22 patients with residual maxillary teeth underwent prosthetic rehabilitation with supplementary placement of implant/tooth-supported telescopic prostheses. A total of 60 supplementary implants were placed in strategic position and connected with 48 natural abutment teeth using telescopic crowns. The follow-up registration included implant and natural tooth survival rates as well as peri-implant and periodontal parameters, along with prosthetic maintenance. Natural tooth abutments were additionally followed to compare their periodontal parameters at baseline and follow-up examination. Based on the retrospective clinical review, the authors concluded that: (I) successful function over a prolonged period and with a minor complication rate of implant/tooth-supported telescopic maxillary dentures may be anticipated; (II) there is a great variety of treatment modalities offered by the use of tooth/implant-supported telescopic prostheses in elderly patients.

Lindh[19] arose a controversial question, which still remains after three decades of debate, regarding tooth/implant-supported prostheses. The author assessed what support could be found in the literature to explain tooth extraction in favor of implant placement, and to elucidate whether tooth/implant-supported prostheses were inferior to solely implant supported constructions in terms of survival and complications. According to the author, the results showed that there was no support for extracting teeth in favor of implant placement. On the contrary, healthy teeth presented greater survival rates. The use of implant/tooth-supported prostheses is also endorsed in certain situations with solid, but limited scientific support. In a wider sense, such prostheses could be used as a reliable therapy in all regions of the mandibular arch. However the status of the abutment teeth in terms of periodontal support, pulpal status and risk of carious lesions and biomechanical complications should always be considered in relation to the long-term prognosis of the prosthesis.

Lin, Wang and Chang[20] investigated, by means of a three-dimensional non-linear finite element approach, the biomechanical interactions in tooth/implant-supported fixed partial dentures under several loading conditions with different numbers of splinted teeth and connector types (rigid and non-rigid). The authors concluded that the loading condition is the main factor affecting stress distribution in different components (bone, prosthesis and implant) of implant/tooth-supported FPD. Minimizing the occlusal loading force on the pontic area by means of selective wearing procedures could reduce the stress values. A non-rigid connector may more efficiently compensate for the dissimilar mobility between the implant and natural teeth under axial loading forces but with the risk of increasing unfavorable stresses in the prosthesis.

Nickenig et al[21] assessed and compared the clinical outcomes of implant/tooth—supported fixed and removable partial dentures in a group of partially edentulous patients. Biological and technical complications were recorded and reviewed. A retrospective analysis of the dental records of 224 patients with a mean age of 51.3 years was carried out. The assessment included details regarding the biological and technical complications of the prescribed prostheses, and complications associated with both types of abutments used.

According to the authors, the survival data for both types of prosthesis were comparable to prostheses supported solely by implants. There was no difference in the complication rate between primary splinting (fixed) and secondary splinting with telescopic systems (removable). A greater risk of biological complications was recorded for endodontically treated abutments or teeth with a reduced attachment level.

DISCUSSION

Fixed prostheses in which natural teeth connect with osseoitnegrated implants are still a controversial issue. The advent of implants brought new possibilities to the rehabilitation of total or partially edentulous patients. Nevertheless, since it is a relatively new and scientifically supported science, it does not have well-established clinical protocols that ensure its use in a safe and proper manner. In this context, it is necessary to establish, on the basis of scientific literature, concepts that allow the clinician to carry out treatment with tooth/implant-supported prostheses, making it a feasible treatment option that contemplates new restorative therapeutic possibilities.

Sullivan,[10] in 1986, already discussed the effects of osseointegrated implants attached to natural teeth in partially edentulous arches with rigid connections. In this context, decreased tooth mobility provided by periodontal ligaments could cause alterations in the long run. Such alterations result from hypofunction. They cause periodontal ligament thinning and increase the medullary spaces of adjacent bone, thus causing the tooth to become more susceptible to periodontal inflammation. Nevertheless, it is worth noting that complete immobility does not occur due to the flexibility inherent to prosthetic segments which are usually made of metal. Furthermore, bone and titanium have elasticity standards that, when in combination, have values between 100 and 200 mm, similarly to periodontal ligament resilience values.

According to Jemt et al,[22] implant/tooth—supported prosthesis may be used in specific cases due to economical and/or mechanical reasons. In these cases, an abutment tooth tends to function as a bridge in relation to the implants, which implies in a concentration of forces in the area between the tooth and the implant. Therefore, this treatment approach must be cautiously addressed, especially in the maxillary arch.

Since tooth and implant are elements of different nature, movement of prosthetic abutments is a major restorative challenge, especially if immobility of rigid connections is considered. Natural teeth have a degree of movement ten times greater than osseointegrated implants. Whenever natural teeth are connected with implants by means of a rigid fixed prosthesis, the total load is supported by each element in proportion to their hardness, which increases the additional overload exerted on the implant bone interface. Thus, non-rigid connections have been used to compensate for the differences in stiffness, acting as stress-breakers.[2] Skalak[5] proposed the need for resilient elements, possibly ring-shaped, that should be inserted between the implant and the prosthesis so as to mimic natural teeth displacement and, as a result, minimize the differences in displacement and equally distribute the load applied to the abutments.

Weinberg and Kruger[11] classified tooth and implant movement into three types: (I) macromovement (0.5 to 1 mm) for teeth with deficient periodontal support; (II) micromovement (0.1 to 0.5 mm) for teeth with periodontal support; and (III) micromovement (> 0.1 mm) for osseointegrated implants. As far as we can see, there is a clear difference in mobility between teeth and implants. Natural teeth have periodontal ligaments with proprioceptors that sense pressure and pain. Periodontal fibers are disposed and originated in such a way that allows them to effectively act against occlusal forces — they are real elastic cushions! Conversely, implants do not have a periodontal ligament, but are biomechanically attached to material such as titanium and bone that effectively act. Nevertheless, the dissipation and action of forces exerted over implants is a critical issue, since implants cannot support intense lateral or transverse forces, but can only support forces in their long axis.

The use of rigid and non-rigid connections remains controversial,[20] with minor or insignificant differences between these options. Nevertheless, long-term radiographic examinations of implant/tooth—supported prostheses reveal more bone loss around implants with rigid connections in comparison to non-rigid ones.[2] Thus, the literature does not reach a consensus regarding the most appropriate connector design for implant/tooth—supported systems.

Mobility of teeth with healthy periodontal ligament may vary between 50 and 200 mm, whereas mobility of osseointegrated implants is not greater than 10 mm. This fact suggests that the physiological movement of the teeth may cause the prosthesis to act as a cantilever, which results in overload that, in turn, may cause peri-implant marginal bone resorption and potential failure in osseointegration. For this reason, non-rigid connectors have been recommended. However, the use of non-rigid connections is associated with intrusion of abutment teeth.[16]

With regard to potential complications, Albrektsson et al[23] suggested some criteria that determine implant success, namely: signs of infection, pain, neuropathies, paresthesia, abutment mobility or increased bone loss — less than 0.2 mm within the first year in function — and absence of peri-implant radiolucency. Furthermore, success rates of 85% 5 years after placement and 80% ten years after placement are minimal criteria to determine implant success.[13]

Thus, attaching a tooth to an implant using a rigid connection restrains tooth movement, which may cause atrophic changes in the periodontal ligament. Furthermore, it is worth noting that the incidence of forces may cause complications such as intrusion of natural teeth,[8] abutment screw loosening,[9] peri-implant bone resorption or even loss of osseointegration.[9,15] In addition to the problems caused by the difference in mobility between prosthetic abutments, material of low flexural resistance are more likely to fracture. Therefore, choosing the most appropriate material, their properties and connection, as well as the financial aspects related to treatment must be considered.

This literature review leads us to conclude that proper planning is highly necessary. It must include mechanical, biological, economical and personal aspects in order to provide patients with feasible treatment options with greater survival rates.

CONCLUSION

Based on the results of this study it is reasonable to conclude that:

1) Implant/tooth—supported prostheses are a feasible treatment approach that meets the needs of partially edentulous patients.

2) Correct planning is key to success and survival of treatment carried out with implant/tooth—supported partial prostheses.

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

Periodontitis, implant loss and peri-implantitis. A meta-analysis.

Sgolastra F, Petrucci A, Severino M, Gatto R, Monaco A. Clin Oral Implants Res. 2013 Dec 31.

Objective: The aim of the present systematic review and meta-analysis was to assess the role of periodontal disease as a risk factor for implant loss, peri-implantitis and implant-bone loss. *Material and Methods:* Six electronic database and a manual search resulted in 7391 unique publications; after selection only 16 studies were included in systematic review. Dichotomous data were expressed as risk ratio (RR) and 95% confidence interval (CI), while continuous data were expressed as standardized mean difference (SMD). Due to the expected inter-study heterogeneity, a random effect model was used for both type of data. The pooled effect was considered significant for a $P < 0.05$. *Results:* Meta-analysis revealed that a higher and significant risk for implant loss was present in patients affected by PD (RR: 1.69, 95% CI: 1.31-2.17, $P < 0.0001$). A higher and significant IBL was present in patients with periodontal disease, when compared with patients periodontally healthy (SMD: 0.38, 95% CI: 0.18-0.58, $P = 0.0002$). Patients periodontally compromised showed an increased risk of PI, when compared with patients without periodontitis (RR: 2.17, 95% CI: 1.51-3.12, $P < 0.0001$) No evidence of significant heterogeneity was detected for the three outcomes. *Conclusion:* Strong evidence suggests that periodontitis is a risk factor for implant loss; moderate evidence revealed that periodontitis is a risk factor for peri-implantitis and that patients with periodontitis have higher implant-bone loss.

Clinical and radiographic evaluation of narrow- vs. regular-diameter dental implants: a 3-year follow-up. A retrospective study.

Zweers J, van Doornik A, Hogendorf EAH, Quirynen M, Van der Weijden GA. Clin Oral Impl Res. Published online: 20/12/2013.

Objectives: Narrow-diameter implants (NDIs) are used in severely resorbed mandibles. The reduced implant diameter means a reduction in the total contact surface between the implant and bone. The question arises whether the implant can be sufficiently osseointegrated to withstand loading forces. If not, marginal bone loss can result from overload. The aim of this retrospective study was to compare clinical and radiographic measurements and patient satisfaction of NDIs with those of regular-diameter implants (RDIs) placed in edentulous patients to support an overdenture via either a ball or a locator connection. *Material and Methods:* Retrospectively over a 7-year period, a total 119 patients fulfilled the inclusion criteria and were selected for this study. The patients received two 3.3- or 4.1-mm-diameter standard titanium implants in the mandible to support an overdenture. At maintenance examinations after 1 and 3 years, clinical peri-implant and prosthetic conditions, marginal bone (MB) and patient satisfaction were investigated. *Results:* None of the 238 implants were lost during the 3-year follow-up period. Overall MB loss was statistically higher in the NDI group when compared with the RDI group. At the site level, a greater MB loss was observed at the distal side of both implant types. Implants with a locator showed significantly greater MB loss (0.38 mm) compared with the implants with a ball attachment (0.14 mm) over the two-year evaluation period (P = 0.006). Patient satisfaction significantly favoured the NDI (8.3) and the locator attachment (8.6). *Conclusions:* The results suggest that during the first three years after implantation, NDIs were associated with more marginal bone loss compared with RDIs. Regardless of implant diameter, the locator attachment showed more marginal bone loss over time compared with the ball attachment.

Loss of pulp vitality after maxillary sinus augmentation: a surgical and endodontic approach.

Romanos GE, Papadimitriou DE, Hoyo MJ, Caton JG. J Periodontol. 2014 Jan;85(1):43-9.

Background: Maxillary sinus augmentation is a routine procedure performed in implant Dentistry in cases with sinus pneumatization. This study presents a series of clinical cases in which tooth devitalization occurred in conjunction with sinus augmentation. *Methods:* In the three cases presented, a sinus-lift procedure was performed that resulted in devitalization of the adjacent teeth. Patients were referred to an endodontist for evaluation and treatment. Vitality of the teeth was determined by the use of a cold test, electric pulp test, and cavity test. The pulp was considered to be necrotic if the tests were negative. *Results:* In this case series, loss of pulp vitality of two maxillary left second premolars and one maxillary left first molar occurs after sinus-augmentation procedures. The devitalized teeth were free of caries. In one case, two amalgam restorations were present. *Conclusion:* Pulp necrosis may occur in conjunction with a sinus-lift procedure in cases when an adjacent root is in close proximity to the sinus floor and the sinus membrane is elevated over the root apex.

Patients' perspectives on dental implant and bone graft surgery: questionnaire-based interview survey.

Hof M, Tepper G, Semo B, Arnhart C, Watzek G, Pommer B. Clin Oral Implants Res. 2014 Jan;25(1):42-5.

Objective: To assess up-to-date expectations and preferences of patients seeking dental implants. *Material and Methods:* One hundred and fifty consecutive patients (66 male and 84 female interviewees) were asked to rank their concerns regarding implant therapy and answer a questionnaire on implant and bone graft surgery, cost and time considerations and second-opinion behaviour. *Results:* Treatment predictability and avoidance of removable dentures were ranked high priority (compared with time and cost efficiency or avoidance of bone grafts). Patients' estimation of the 10-year implant success rate was 84%, and 59% of patients expected implants to last for a lifetime. Total treatment time was estimated to be 4 months on average, and only 12% would tolerate increased risk of implant failure for the sake of shortening treatment duration. 61% of interviewees accepted autologous bone grafts (the majority favouring the retromolar area), while only 23% were willing to undergo bone harvesting from the hip. 43% opted for bone substitute material to avoid donor site morbidity. 67% would accept the additional costs associated with computed tomography, software-based treatment planning and guided implant placement to avoid bone graft surgery. Motivation for second-opinion seeking was high (46-62%), especially in young and male patients. *Conclusion:* Patient expectations on implant success and predictability are high compared with their reluctance towards treatment costs and duration. Acceptance of treatment morbidity is high among patients reporting low denture satisfaction; however, minimally invasive treatment alternatives are generally preferred.

Factors influencing treatment decision-making for maintaining or extracting compromised teeth.

Lang-Hua BH, McGrath CP, Lo EC, Lang NP. Clin Oral Implants Res. 2014 Jan;25(1):59-66.

Objective: To evaluate treatment decision-making with respect to maintaining periodontally compromised teeth among dentists with or without postgraduate qualifications in implant Dentistry. *Material and Methods:* A series of patient scenarios with varying degrees of periodontal disease levels was presented to dental practitioners. Practitioners' decision-making outcome was determined, and intention to retain the compromised teeth was analyzed in bivariate and regression analyses (accounting for postgraduate implant training, gender, years in dental practice, and implant placement experience). *Results:* This study involved 30 dental practitioners with postgraduate implant qualifications (GDPP), 33 dental practitioners without postgraduate implant qualifications (GDP), and 27 practitioners undergoing training for postgraduate implant qualifications (GDPT). Variations in treatment decision-making were evident between the three groups. Differences in treatment approaches to retaining compromised teeth were apparent. Furthermore, variations in rehabilitation of extracted scenarios existed in terms of use of implant and number of implants need for rehabilitation. Accounting for dentist and practice factors in regression analyses, GDPP/GDPT were three times

as likely to retain periodontally compromised upper molar, with or without pain, compared to GDP (without pain OR 3.10, 95%CI 1.04, 10.62 P = 0.04; with pain OR 3.08, 95%CI 1.09, 8.14 P = 0.03). *Conclusion:* Variations in treatment decision-making with respect to retaining periodontally compromised teeth exist between dental practitioners with and those without postgraduate training in implant dentistry. Furthermore differences in management approaches in how they would retain the teeth or rehabilitate the dental arch were apparent.

Demineralization of the contacting surfaces in autologous onlay bone grafts improves bone formation and bone consolidation.

Rezende ML, Consolaro A, Sant'Ana AC, Damante CA, Greghi SL, Passanezi E. J Periodontol. 2013 Oct 30.

Background: Autologous bone grafts are usually well consolidated after 4 to 5 months, but can be incompletely interlocked with the native bone. This study investigated the effect of acid demineralization of the graft-bed interface on graft consolidation. *Methods:* Onlay bone grafts were performed on the calvaria of 36 guinea pigs. Half of the animals had the graft-bed contacting surfaces demineralized with 50% citric acid (pH 1.0) for 3 minutes (test group). The other half received no demineralization (control group). The bone grafts were immobilized by a resorbable membrane glued to the recipient bed with cyanoacrylate. After 7, 30, and 90 days, specimens (n = 6) were obtained for light microscopy. Data from qualitative analysis and computerized histomorphometry were statistically processed at a significance level of 5%. *Results:* Osteogenesis was not seen at the interface after 7 days. After 30 days, the test group showed 34.39% ± 13.4% of the interface area filled with mineralized tissue, compared to 17.14% ± 8.6% in the control group (P = 0.026). After 90 days, the mean percentages of mineralized tissue at the interface in the test and control specimens were 54.00% ± 11.23% and 38.65% ± 7.76% (P = 0.041), respectively. Within groups, a higher percentage of the area filled with mineralized tissue was seen at 90 days compared to 30 days (P = 0.004 for control and 0.041 for test). *Conclusions:* Demineralization of the contacting surfaces between autologous bone graft and bone bed improved new bone formation and bone consolidation. These data need to be confirmed in humans.

Osteotome sinus floor elevation with and without grafting: an animal study in Labrador dogs.

Si MS, Mo JJ, Zhuang LF, Gu YX, Qiao SC, Lai HC. Clin Oral Implants Res. 2013 Dec 20.

Objective: To evaluate implant stability and histological outcomes after osteotome sinus floor elevation (OSFE) procedure, and to compare new bone formation and implant osseointegration with and without grafting. *Material and Methods:* OSFE with simultaneous implant placement was conducted bilaterally on six Labrador dogs. Twenty-four implants were placed. The right side sinus (Group 1) was grafted with biphasic calcium phosphate (BCP), whereas the left side (Group 2) was left without any grafting materials. The animals were euthanized 8 and 24 weeks after surgery for histological and histomorphometric assessment. Bone-to-implant contact (BIC%), alveolar bone height (ABH), bone density (BD) and grafting material density (GMD) were measured. The implant stability (ISQ) was assessed using resonance frequency analysis (RFA) at implant placement and 1, 2, 4, 8, 12, 24 weeks after surgery. *Results:* Endo-sinus new bone with direct contact to implant surface were observed in two groups at both time points. ABH showed no difference between groups at both time points. BIC% and BD in Group 2 (40.05%, 35.90%) was higher than those in Group 1 (23.30%,25.59%) at 24 weeks. Significant shrinkage of grafting material was seen in Group 1. The GMD in Group 1 at 8 weeks was 24.35%, while it dropped to 19.90% at 24 weeks. The changing pattern of ISQ for both groups were similar. *Conclusions:* Spontaneous new bone formation and better bone-to-implant contact were found for OSFE without grafting. The grafting material application during OSFE procedure showed no advantages in histological results.

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