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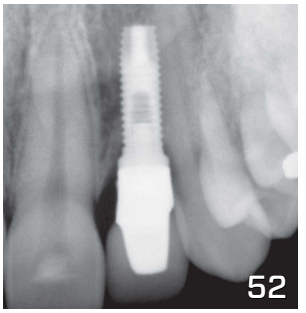
Ask the Expert

Explanations and Applications

Image and Science



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Science and technology are different things!

To think and to know represent the essence of men. Thinking is a prerogative, a right and an obligation that is exclusively human. Knowing is the reason why we exist, and it is not by chance that in Brazilian Portuguese "to know" has the same etymological origin as "to taste".

True knowledge reaches the reason and the cause of things, not only the things. As man endeavors to exceed the limits of simply knowing something — by means of thinking and reflecting upon that — the basic elements of scientific production emerge: criticism and objectivity.

Science is not the only way to discover the truth; we also have empirical, sensory and other types of knowledge. But scientific knowledge is different because it analyzes, explains, induces and applies the natural law. For being programmed, methodical and sequential, its repeatability is certain. Science necessarily produces public knowledge and provides results that may be repeated by anybody, anywhere. Science is connected to finding the truth, producing new knowledge, but it is also related to the obligation of disclosing it. If it is not public, it is not science.

Science and technology are always together, but many people are not able to distinguish the difference between them, some even think that they are synonyms. In Science & Technology, or simply S&T, we usually find the letter "&" between them. As if they have nothing to do with each other, but they do! Take the Ministry of Science & Technology, for instance.

Technology is connected to the practical application of knowledge and it is associated with progress in daily life, which is a result of scientific knowledge. Technology is also related to manufacture and feasibility as well as commercial, industrial and strategic interests. Science may be useful to technological progress, but not necessarily, as it is committed to knowledge on its own. Technology may be useful to science progress by developing new devices, equipment as well as observation and analysis techniques.

The difference between science and technology may seem subtle, but it is not, and every person could be able to notice it. The progress of mankind depends on science and production of knowledge. Technology, however, is our working tool.

Why does science have to be public while technology does not? Technology is connected to patents and commercial trademarks. Technology is related to the industrial and business world as well as to money. In other words, it is connected to power, profit and the supremacy of some people, cities or companies over others.

When a researcher, scientist or inventor publishes something, he no longer has the right to apply for patents, neither register any brands or other financial and material benefits. Once knowledge has been published, it enters into the public domain. Santos Dumont did not patent the airplane, neither the watch; Röntgen did not patent the X-ray generator, but Nobel patented the dynamite and made a fortune with that. Knowledge that is produced and kept to and by whom it was produced, is useful to itself, to generate profit and power.

A country that wishes to be influential, dominant and wealthy stimulates application for patents and trademarks. There are some international standards used to classify a country according to the number of patents and trademarks it has got. The more patents and trademarks a country has got, the more powerful it is considered among other nations.

When making medicines, cars, guns, toys, computers and nearly everything, a country needs to pay for the rights of patents and trademarks. The more Brazilian researches, companies and laboratories retain the rights over patents and trademarks, the more money we will receive from other countries. That means power and domain. Whether it is good or bad, that is another story. But that is how it works!

In Implantology, when reading a published article, the reader must question its scope — or intention — whether it is scientific or technological! Does the analyzed work display knowledge or it reveals an opportunity for sale or to display a work, protocol or a product? Science and Technology must walk together and have to be licit, but we cannot think that they are synonyms; on the contrary, they are different processes and we must bear that in mind. Let's think about that.

Editors

Prof. Dr. Carlos Eduardo Francischone
Prof. Dr. Alberto Consolaro

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Curtis Jansen

Dr. Curtis Jansen received his dental degree and a certificate in advanced education in Prosthodontics at the University of Southern California (USC), where he went on to teach in the department of Restorative Dentistry and worked as director of the Implant Dentistry department. He also worked with a dental implant manufacturer in Florida and was extensively involved in the research, design, and development of a number of patented implant restorative components used by major manufacturers today. Dr. Jansen lectures widely and owns a private prosthodontics practice in Monterey, Calif., with an on-site dental laboratory. He spoke with Dr. Bradley Bockhorst, former director of Clinical Technologies at Glidewell Laboratories, Newport Beach, California.

I know you've just spent six hours lecturing at the California Dental Association (CDA) meeting, so I appreciate you coming out here to spend a little time with us. During your presentation at the Academy of Osseointegration (AO) Annual Meeting last March, one of the things you talked about was the "money tooth." Can you expand on that for us?

I'm always trying to think how I can motivate and educate doctors — and there's no better way than with money. So many people are standoffish about the whole concept of intraoral scanning or same-day dentistry. Everybody likes to talk about anterior teeth and how pretty they are, and how we can achieve esthetic results. But what drives doctors' practices, what pays for their mortgages and their fancy cars, is single-tooth dentistry. And if we break it down even more, when we're talking to those who are doing implants, it's lower mandibular molars. For a lot of the bigger surgeons, it may be as much as 25 percent of the time that they pick up a handpiece or put in an implant that they're replacing mandibular molars. For me, if I break up my practice into single crowns and single implants, it's mandibular and maxillary first molars. I'm either replacing or restoring first molars. It's the "money tooth" — and I love it!

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Do you think part of that is because it's the first tooth to come in, so it's the first tooth to come out?

Right. I think that it's the first tooth that gets the early composite, or the early alloy, and it may just break down. Then one thing leads to another. What's surprising is that 80 percent of dentistry is "re-dentistry." Rarely are we treating a tooth for the first time, and that tooth is the tooth that gets beat up first, gets the endo, so it is the one that comes out first. I think that holds true for a lot of implant restorations and a lot of full-coverage restorations.

At one point you said that 75 percent of the cases you evaluated involved first molars. Is that a true statement?

Yes and no. I found in talking to many surgeons placing implants that about 70 percent of the implants they place are posterior, either single or multiple units. About 45 percent are single posterior implants. When you get down to mandibular first molars, they account for about 25 percent of the posterior implants being placed. I'd be very curious about what you guys do here at Glidewell, and on which restorations you do the most crowns. You've got cases coming in from many different places, but I bet you're keeping pretty good numbers.

After I saw your AO presentation, I came back to the office and looked up Glidewell stats for custom implant abutments: 29 percent of the custom abutments we do are first molars.

So it holds true!

Everybody talks like it's the full-arch cases, but it's those single units that really are the bread and butter.

It is. That's why my perspective is to try to get through to these individuals who are so highbrow, who think, "How could you do that?". If they break it down, they can really see where their business is. Glidewell is extremely good at that. That's how I try to get through to the stubborn ones. I say, give me single posteriors, let us talk about this one area of your practice, and I think you could utilize intraoral scanning. You could do a lot of things to be more productive.

Another thing I'd like to talk to you about is technology. What do you see as being the most significant technologies impacting dentistry right now? Which ones are you incorporating into your practice?

The greatest advancement in dental technology I see out there — and I think it's incredible — is digital, obviously. If we break down digital into digital radiographs and things like that, I think that's it. But for me right now, as a restorative doctor, it has to do with intraoral scanning. I think there's a huge misconception out there and so many doctors are turned off by same-day dentistry. I call it "SDD" and "NDD," next-day dentistry. For me, there is no question about it: The most significant thing that I've incorporated in my practice is not only intraoral scanning, but also lab scanning. Then we get into implants. I like to do a fair number of implants. I like to scan abutments. Glidewell has a very nice abutment. Some of the other manufacturers have nice abutments. I can't tell you how antiquated it is for me to take off a healing abutment, put on an impression coping and make a conventional impression. I've only been doing digital scanning with implant restorations for about six months now, but conventional impressions for implants already seem so last year I just can't believe it!

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I got a kick out of one of your talks from a couple of years ago when you said, "People, can we make this any more complicated?" And now the question is, "What's changed?"

What's changed? It's scanning! Intraoral scanning abutments. But make no mistake about it, I don't think it's necessarily only intraoral scanning. Nor do I think conventional impressions are going away anytime soon. But for me, intraoral scanning and lab scanning are a big deal. Then if you take it even further, what you guys at Glidewell have done beautifully is introduce the one-fee. You talk about mandibular first molars, and that's what is going to drive their practice. So many doctors are doing single posterior implants. But many restorative dentists have a problem, and they want to make a referral to an oral surgeon or a periodontist. Often this referral makes things harder. The patient can get lost and confused during the referral process. The patient ought to be able to just go up to the front desk and say: "Hey, your doctor just said I should have an implant. I'm ready to go. I want to pay for everything, right here." But so many times we just screw it all up during the referral process.

The one-fee philosophy, can you talk more about that?

Talking about what's big for me, practice management-wise — we can talk parts and pieces, intraoral scanning, doing it in the lab, doing it different ways. But from a practice management philosophy, running the practice and seeing the patients who want it white, W-H-I-T-E, and they want it white now, most patients are ready to make decisions fast. We've got Netflix, and the 29-minute oil/lube from Pep Boys — all these things influencing patient expectations. Patients want and expect things to happen quickly, and they're willing to pay for it. And they want one-fee. They don't want to be overwhelmed with, for example, "Oh, it's a graft, and it's this part, and it's that part." They just want to know what it costs, and they're ready to go. The hysterical thing is — maybe you've heard me talk about this — that doctors think they somehow have to justify their fees and have a bunch of appointments. But patients are paying for perceived value; they're not paying for appointments.

Right. And that leads right into our patients' perception of the technology that we're using. There is the clinical utility, but also the practice management aspect of it.

It's huge. I think doctors miss this aspect, which is a very big component of practice management. Most dentists — and I'm not claiming to be one of them — are getting a lot smarter. But we're not business people, as you know.

I want to take a step back and discuss some of the details of the technology. You mentioned before that you have multiple intraoral scanners. Which ones do you have, why do you have several and which do you use where?

Well, I'm a restorative guy, and I'm a curious guy. I've got to have a little of everything. I've got three of the four widely used digital impression systems in my office. I tend to use one more than another — but they're apples and oranges. I don't have to explain that to you, but I think we have to explain that to the readers. Two of these systems have an associated mill that allows me to do same-day dentistry. Two are merely impression material substitutes, and I don't mean to degrade those. But to me, that's all those really are. I can use those to make impressions and then I can do fancy things with them — I can send the data to you, and I can save twenty bucks or more on my lab bill. With the other ones, I can do Invisalign® cases (Align Technology; San Jose, Calif.).

So does the average restorative doctor need three or four systems in their office? Absolutely not. But they have a big decision to make. They need to decide, for instance, if they merely want to have a substitute for impression materials. If I'm using Cadent iTero™ (Align Technology) or Lava™ Chairside Oral Scanner C.O.S. (3M ESPE; St. Paul, Minn.), they're both very nice systems, but I don't see a model for three to five days. Now, maybe I don't need a model, but I still like my model. I can do a rehab in three to five days. I've got E4D® Dentist (D4D Technologies; Richardson, Texas) in the office, and I've got an attached mill. So I can still do intraoral impressions, I can do lab impressions; but I can also fabricate a restoration on the same day. E4D is probably my favorite from that perspective. But the coolest scanning technology, I think, is Lava C.O.S. It's live, streaming video. The easiest one that I can do all by myself, from a scanning perspective — behind my back, underneath my leg — is Cadent iTero. I can do a pirouette on the tooth with the scanning wand and the data is good. There are a lot of things to consider for restorative doctors, but the biggest decision is whether they are ready to do same-day dentistry in their office, or they want to be able to partner with a lab like you. I would imagine that you're going to start really incentivizing doctors to do some of this stuff.

We receive a huge number of cases using various scanners, and we accept digital scans from all systems that are out there on the market. So have you gone model-less yet?

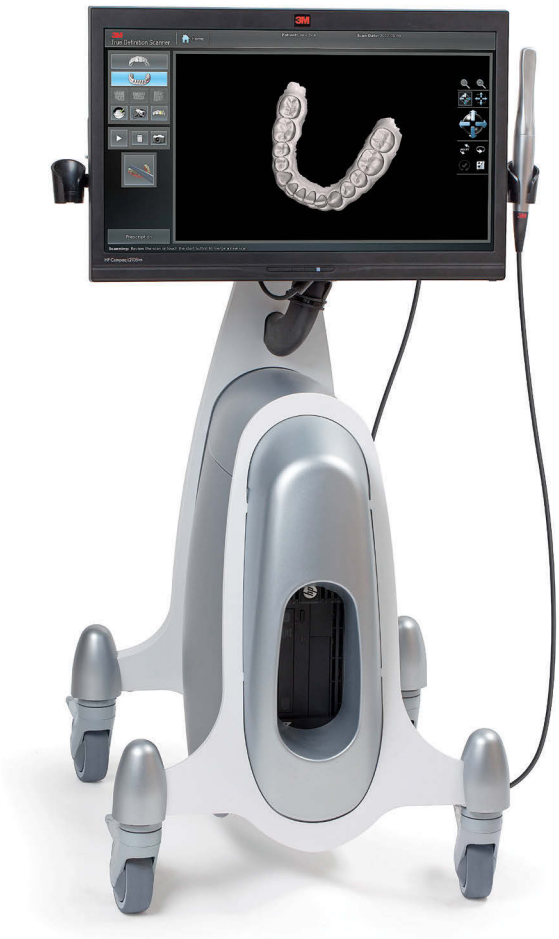
That's the tough part. You know, as much as I'd love to go model-less, I'm just not there yet. It's very difficult for me. I like to check my contacts — I like a little clacker! But I'm trying. I've been using a digital scanner since October 2008. I have to say one more thing, for doctors who are making a decision about going digital: Try to get all the information on all the systems, not just what you hear your buddies talking about. There are so many cult-like things in dentistry. You have these different groups or any one of a number of different organizations pushing a particular system, so be careful. But going model-less, that's a big deal. I think we have to start in the dental schools. What I want to find out is how I can get a printer from you guys because I hate making impressions! But I just can't wait three to five days for a model — it's too long. I like the idea of printing or milling a model in my office the same day.

Heading toward model-less is key for us, too. If you can avoid those steps that are part of conventional impression-taking, not only do you avoid potential errors, but you can obviously move things along more quickly.

With the labor and time and effort that's involved, a majority of doctors don't pour their own impressions.

And the ones I've seen that they have poured make us wish they hadn't!

That's very true. Lee Culp, CDT, chief technology officer of Digital Technologies Inc. (DTI) in Dublin, Calif., has said that 95 percent of doctors do not pour their own impressions. To me, that's a fascinating statistic.



If we can do more intraoral scanning and then go model-less, that's going to be a big deal.

So are you using intraoral scanning for all of your implant cases?

When you look at my conventional dentistry — say I'm doing six restorations in the anterior —, I'll prep and provisionalize conventionally, get the provisionals as nice as I can, make a conventional impression of the patient-approved provisionals and then go into the lab and scan everything: the prep, the model of the provisionals and the opposing dentition. Those are all lab scans. Then I will design and mill the restorations using the provisionals as a guide. But for my implants, it's almost 100 percent intraoral digital scanning. If I can, I'll solely do intraoral scanning with implant restorations. Then design the abutment and restoration. It's just so much easier with implants. I can justify the time and the wait because I'm going to get a model and an abutment several days later. I'm not just waiting for a model. I love this concept of concurrent manufacturing. From the intraoral scan I design the implant abutment; from there I send the information to an abutment manufacturer. They can then mill the abutment and print or mill a model of the abutment and the actual abutment. But I find it difficult to do that with conventional dentistry. I have to wait three to five days just for a model before I can start any lab work. With implants, it makes perfect sense for me.

For those implant cases, do you immediately provisionalize them routinely?

For my implant cases, I think one of the biggest new options out there is the ClearChoice® model (ClearChoice Dental Implant Centers; Greenwood Village, Colo.) with their same-day restoration option. ClearChoice works only with oral surgeons and

prosthodontists, and they advertise big time. ClearChoice has done more for prosthodontists with their advertising than anybody else. But at the same time, I think they're the scariest thing out there, some serious competition. I want to be like ClearChoice — I want to try to take them on. They're doing a really good job, but I think maybe I can do better. But for the concept that they have, this same-day immediate tooth, my office is too small. I built the wrong office. I'll do some same-day dentistry that's just conventional dentistry. But many times I'll be doing immediate non-occlusal loading, or I'll do an All-on-4™ (Nobel Biocare; Yorba Linda, Calif.) case on implants. I don't think there's anything bigger in my practice to make patients happier than allowing them to get rid of their beat-up, useless mandibular or maxillary dentition, put in four to five implants and give them fixed teeth the same day. Loading the implants the same day, that's big. It will be interesting to see how Glidewell addresses this because a lot of doctors don't know how to do this type of dentistry. Glidewell is good at educating doctors on products, and there is great opportunity to do the same with procedures. I just think we need so much help from the laboratory for these immediate-load implants. I can do it. But the average guys out there, they can put in the implants and get it close, but they don't know how to connect a fixed restoration. They don't know how to convert that denture to a fixed restoration. That's going to be the difficult thing. But I think there's a big business model there.

That's exactly one of the projects we're really working on. You're going to see that package in the near future. To go back and clarify something for our audience, ClearChoice is a group of practices with offices around the country, and they primarily do All-on-4. They market to their local communities, and they're really drawing in a lot of patients who had given up on going to the dentist. At one point, I heard a statistic that about 60 percent of patients who go to ClearChoice haven't been to a dentist in more than 10 years. So, their marketing efforts are reaching people. When ClearChoice first comes into a market, dentists are often concerned. But, in actuality, it has really helped educate a lot of people on procedures like All-on-4. What they ultimately find is that the whole market is more educated about implants. So we end up getting more business because of it.

Right. I think it's a good thing.

What's your opinion on putting the abutment in one time, as soon as possible, and then leaving it there?

That's the beauty of what I was doing initially. After confirming that the implant could be loaded, I'd really

take my time with the zirconia abutment. Or I'd use a titanium abutment, but I'd really take my time with it and get it perfect, with margins below the tissue, etc. Then I'd impress it or scan it and put it in the patient's mouth. And people would ask me how I could determine margin placement at the time of surgery. I can do that because I'm working with good surgeons. If a surgeon takes out a tooth and takes a whole buccal cortex out with it, they're going to warn me not to do that one. But 9 times out of 10, the tooth is taken out very atraumatically, the implant is placed, and we know we're not going to have a lot of recession. In those cases — especially with thin biotypes, or highly scalloped tissue — I think it really pays to take as much time as we can to decrease the number of what we call "switches," when the abutment or the impression coping comes on and off the implant. So, if I can leave that abutment on, fantastic. But that's where this whole concept of what I call forecasting comes in. If I could then scan that and come back in 12 weeks, people ask, "How do you get your margins?" Well, I've scanned it outside the mouth. Then I can scan inside the mouth. There are enough data points to where I can merge the two data sets. It's very exciting. If we can, we want to limit the number of switches and transfers because every time we raise a flap, every time we take an abutment off, it sets up a series of consequences, and we lose hard and soft tissue.

You will be presenting on risk management. Can you tell us a little bit about what you're doing along those lines, and what recommendations or suggestions you have for clinicians out there?

Right, this is a great course. It's something that I've done probably the last six or so years with The Dentists Insurance Company (TDIC), which is one of the bigger insurance companies here in California. They use actual malpractice cases as examples in the seminars. I don't know if you've ever sat through one of those courses, but you get a 5 percent reduction on your premium if you do. That's one reason why the people are there, but these seminars are also very helpful. An attorney and a restorative dentist present four to five different patient situations and review various learning points. We're going to draw more than 1,000 people over the next three days. One of the common themes is recordkeeping. Doctors keep miserable records, and at times they pay for it because they can't defend themselves. We have so many responsibilities as clinicians, and at times we may get sloppy with recordkeeping. What I would recommend for doctors is consent forms, which is kind of a given. You can go to www.thedentists.com and get consent forms. But for some of these cases, it's bigger than just a consent form. You need certain things in your treatment notes. If a patient has some type of potential problem and you're worried about, say, a root canal, you've got consent to cover that — but many times it helps to also write in the chart that you spoke to the patient about RBAs (risks, benefits and alternatives) to proposed treatment. The other thing that's very interesting when we talk about implants and these big-ticket items is that you've got these piranhas, these ambulance-chasing attorneys out there. I only work with what I call the "good guys" — only the attorneys who defend. But as far as risk management, I don't think doctors can protect themselves enough from both patients and employees. You can never be Teflon. But you need to look at these consent forms. You need to look at treatment plans. You need to cover yourself the best that you can. I cannot tell you how much help there is with a company like TDIC. It's important to discuss informed refusal on these All-on-4 cases — you're talking about a whole different type of treatment. A lot of people know what informed consent is, but not informed refusal. When you tell Mrs. Stieglewitz that you're going to take out all of her teeth, you're going to give her some implants and

everything is going to be peaches, if it's not all peaches, you've altered a significant portion of her life — it's like taking away an arm or a leg. It's more than just a single-tooth implant. I don't think a lot of doctors get that. When you're talking in that realm, and when you're talking about that kind of money, then you've got some attorneys who are pretty interested in that. And Mrs. Stieglewitz has more of a case to make than that she just didn't get her single tooth. She doesn't have any teeth!

Even before that legal aspect is managing patient expectations, which I'm sure is a huge part of this topic. Can you expand on that?

Again, it's the informed refusal, informed expectations. You have to compare all the available treatment options. If you immediately load some implants and give the patient a fixed restoration on the same day, that's great if it works. But if it doesn't, you have now taken the patient's teeth out and they have nothing but a floating plastic replica of teeth. Oh yeah, and they don't get the fixed one for at least 12 weeks. Well, some patients are not going to be too happy with you, so the topic of patient expectations is huge. You need to tell them what's going to happen if it doesn't work. So, you hit the nail on the head. Patient expectations are a big part of it. And so many doctors are so eager and so enthusiastic to get into the treatment that they forget about that part, if it fails or they can't go fixed the same day. If they don't cover that with their patients, it could be a big problem. Suddenly your records are subpoenaed, and you're asked to give a deposition.

Regarding major catastrophes during implant placement, like injuring a nerve, from your work with the insurance cases, what are the usual things people are getting in trouble over?

The biggest thing is simple informed consent. Like politics, it's not necessarily the damage of the incident; it's how it's handled. And a lot of doctors don't handle it well. And what happens is a second party gets involved, and that's when it gets ugly. Dentists, they just can't help themselves. They can do a simple occlusal alloy, and the guy across the street will find some fault with it. So, it's not necessarily that you see an injured nerve or an implant that fails. Most of the lawsuits I see start from a critical second opinion. The amazing thing, in my experience, has been that somehow juries can always ferret out the truth. I've worked with a lot of attorneys and they have the utmost confidence in juries figuring out the truth. And a lot of times, doctors are less than truthful. What we do is very difficult, and sometimes we just have to ante up and tell the patient that it doesn't always turn out right. It's not going to work right all the time. I think juries understand that. Patients should understand that, too. So I don't think it's necessarily the act itself, it's how these doctors are responding to it. Or, unfortunately, not responding to it, and leaving the patient to their own means. And that's when the patient goes out, finds somebody else and all heck breaks loose. It's really unfortunate. You get paid the big bucks so you need to pick up the phone and deal with the problem. You can't just hope that it goes away, or assign a staff member to deal with it.

We've talked about a lot here. What are some of the things on the horizon that are affecting the future of dentistry?

I just went on a tour of your facility, and the things I saw are fascinating. Talking with Dave Casper [Vice President of Sales & Business Development], some of the things that you're doing are absolutely amazing. Some of the biggest things on the horizon are what you're doing here at Glidewell with intraoral scanning. But more than that, it's patient management — and you guys figuring out that it's about one-fee. Patients look at everything, as with anything. If they're going to buy a couch, they're doing it online. And they don't want to have to chase answers. They want to know what the cost is going to be. So, in terms of patient convenience, what we're doing for patients is the same-day stuff. It's about managing one-fee. It's going to be the coming together of not only parts and pieces, but like we talked about — it's patient management. And you're going to need to help the doctors with that. You've already helped tremendously with your one-fee approach to getting a tooth. They're not just getting an implant. It's not the implant, it's not the prep; it's the restoration they're walking out with. That's what you guys want to do, and that's what patients want. So I think it's a coming together of these technologies: old traditional ways are going to meet hi-tech. Because, at the end of the day, it's about keeping our patients happy. How do we keep them happy? They want technology, and they don't want things to take too long. What an exciting time to be involved in dentistry!

INTERVIEWER

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Surgical strategies for extraction sockets seal

Walter **MARTINS JUNIOR***

The discovery of the biological phenomenon of osseointegration established treatment options that permanently modified the way to rehabilitate partially or totally edentulous patients. Thus, in this contemporary scenario of the profession, a situation of particular clinical interest is that in which the extraction of a dental element is necessary and the choice for actions to be taken for the most adequate solution of the case is decisive to the patient and to the professional.

Some aspects are very important for the decision to install an implant after extraction, generally determined, in clinical practice, by some characteristics presented by the alveolus mucosal and bone tissue.[2] For this reason, several ways have been suggested to classify the moment of installation of the implant in relation to the tooth extraction.[3,4] These proposals are based, mostly, on the repair stages of soft and hard tissues, decisive events to determine the most favorable treatment for each particular case. This way it is possible to establish a protocol that standardize the conduct to be taken, optimizing the achieved results.[5,6]

The classification of Hammerle et al,[7] presented below, is today the most appropriate to define the moment of installation of the implant in relation to the stage of alveolar healing:

- Installation of the implant after tooth extraction, as part of the same surgical procedure — Immediate placement, type 1.
- Installation after the full coverage of soft tissue over the alveolus, generally between 4 and 8 weeks after the extraction — Early placement, type 2.
- Installation after the clinical and/or radiographic substantial fill up of the alveolus, generally between 12 and 16 weeks after the extraction — Late placement, type 3.
- Installation after the complete fill up of the alveolus, generally after 16 weeks – Late placement, type 4.

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It is interesting to observe that in all four situations established in this classification,[7] additional procedures for the sealing of the alveolus are necessary when the prosthetic restoration is not performed immediately or in the initial periods after the implant installation. Although a recent work, assessing the alveolar healing in dogs, has shown excellent regeneration of the area with no action to occlude the alveolus,[8] the full alveolar sealing with soft tissue seems to favor the procedures of healing in humans. The physical interference that can occur during the alveolus tissue reparation, as well as a possible microbial contamination, can be minimized by these maneuvers,[9,10] providing adequate conditions for the period of osseointegration and/or guided bone regeneration and, in many cases, also favoring the aesthetics.[11,12]

Some characteristics are desirable for the adequate handling of the soft tissue on the procedures for alveolus sealing:[13,14]

- The technique must be easy, quick and with high predictability.
- It must be minimally traumatic and invasive.
- Allow the full sealing of the alveolus without tension on the flap and adjacent tissues.
- Favor the aesthetics with maintenance of the vestibule shape, parabolic contour and depth.
- Applicable to unitary and multiple cases.
- Have applicability in guided regenerations.

Due to these considerations, it is interesting a more systematic analysis of the different surgical procedures that allow the alveolus sealing, always verifying that the remaining alveolar bone structures remain integrate or with little compromising in its buccal plate. Thus, the available surgical resources make use of flaps, grafts and barriers on the following described techniques.

Flap

By definition, flap is a section of tissue separated of the adjacent tissues, except for its base[15] (Fig 1). The displaced tissue, for being nourished through a pedicle, presents, theoretically, a prognosis more favorable to the maintenance of its vitality.

Several surgical techniques using different types of flap were developed in the 90s,[16] aiming to promote the sealing of the alveolus and to cover the different membranes used for the procedures of guided bone regeneration developed in this period. These procedures passed through a long evolutionary process of improvement, creating the fundamentals for handling of soft tissues in the peri-implant areas, providing accurate esthetical and functional sophistication to these rehabilitator procedures.

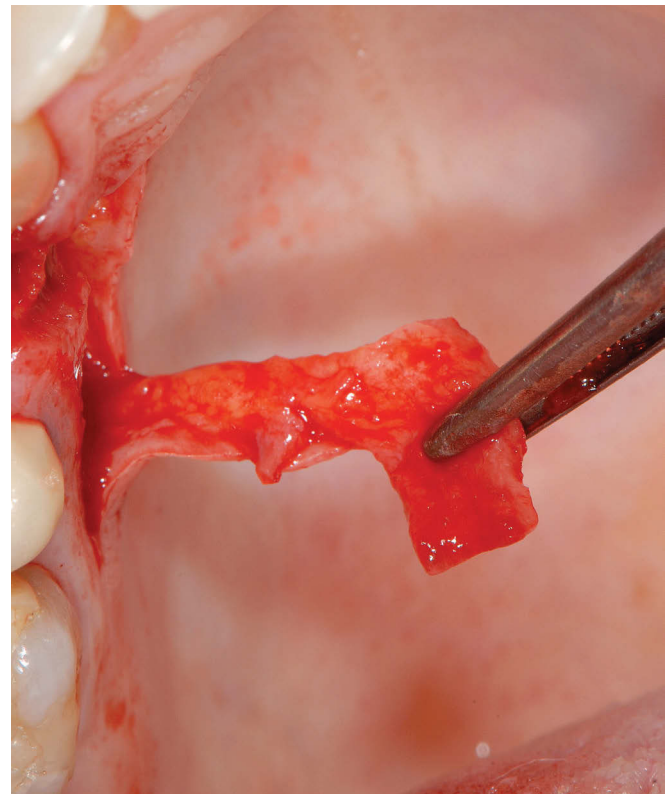

Figure 1 - Flap.

Buccal flap

Becker and Becker[17] were the first to describe one of these reported techniques, which consists, basically, in two relaxing incisions, perpendicular and slightly divergent from the top of the flange to the bottom of the vestibule. Incisions in the periosteum provide a greater mobilization of the full-thickness flap, folded and slipped towards the alveolus for its sealing (Fig 2).

Changes were described soon after.[18,19] Buser et al[20] described a variant for the mandible, in which the flap is made with a epiperiosteal incision on the buccal wall, near to the top of the crest, which continues coronally to the mucogingival junction. At this point, a mucoperiosteal full-flap is mobilized to lingual. The closure is achieved with mattress and interrupted suture techniques.

The main requirement of these procedures is the presence of an adequate keratinized mucosa zone. It must also be considered the aesthetic implication on the decrease of the vestibule depth and the discrepancy of the mucogingival junction in relation to the surrounding area. Its main recommendation must be in upper posterior areas, with little esthetic need, or in inferior areas where the palate is not available for rotation flaps.

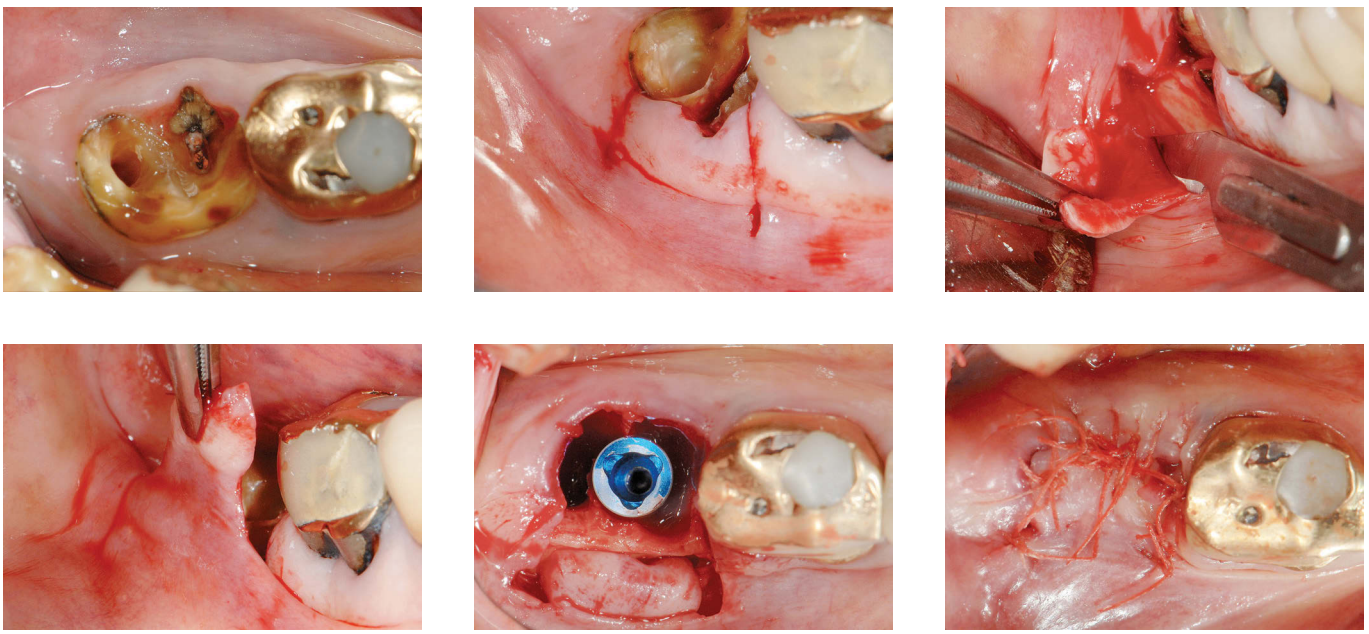

Figure 2 - Buccal flap.

Palatal flap

The possibility to obtain tissue from the palate for the alveolus sealing must be considered for being this a masticatory type mucosa, which is the ideal tissue for biological sealing of the peri-implant sulcus.[21]

This area also allows for the performance of partial or full-flaps. The great limitation of this technique is the presence of the palatine artery near the donor area, which occurs mainly in shallow palates. It must also be considered the possible postoperative discomfort.

Epithelialized palatal flap

Nemcovsky, Artzi and Moses[22] were the first to propose the performance of a rotated epithelialized palatal flap for the closure of the alveolus on the upper arch (Fig 3). The development of this technique is probably originated on flaps for the closure of oroantral fistulas. It is mainly recommended for the molars area and has as main inconvenient the presence of large bloody area in the donor region.

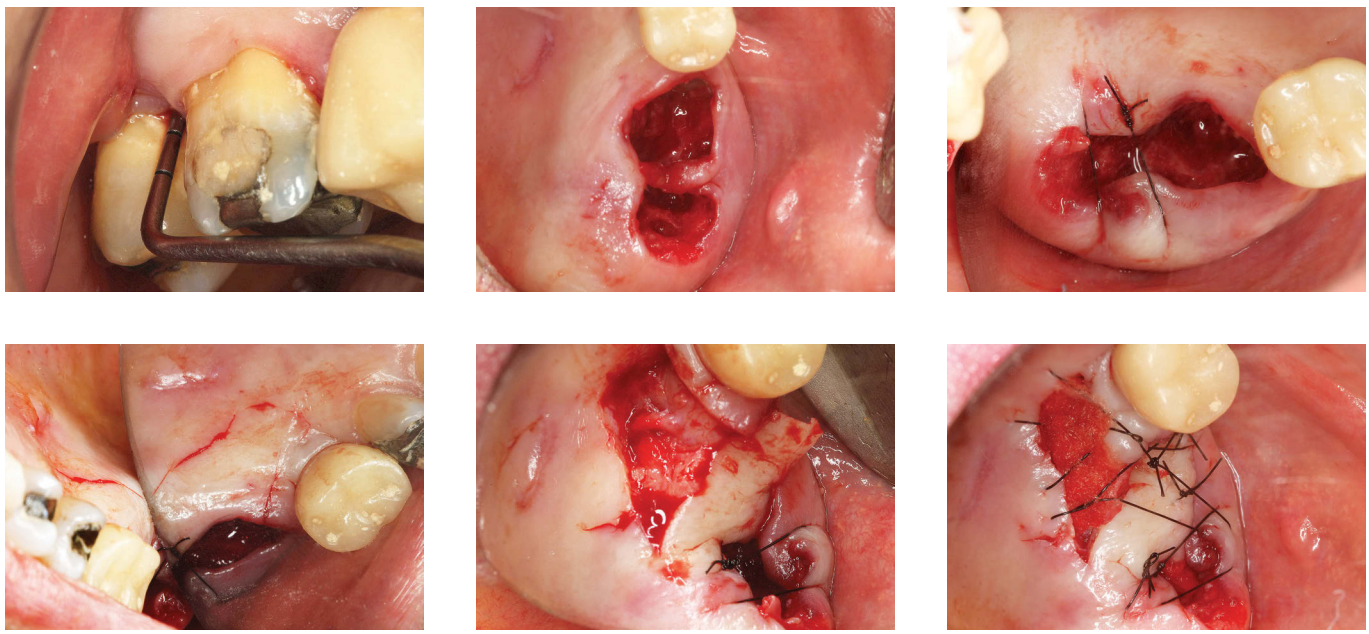

Figure 3 - Epithelialized palatal flap.

"L" shaped epithelialized palatal flap

A neater variation of this procedure was proposed by Neves et al,[23] in 2010, denominated "L" shaped pedicle flap, which allows, by the peculiarities of its design, a better accommodation of the tissue without generating stress on the mobilized tissues. The larger portion of the "L" must be transverse to the alveolus, while the smaller portion must be perpendicular to it. The distance of parallel and perpendicular incisions must have the same dimensions of the alveolus to be closed. A triangular area is marked coronally to the incisions, on the region of the angle formed by the "L". The base of this triangle is located on the smaller portion and the apex, on the distal of the larger portion — this is the technical detail that provide mobility to the flap. For the full sealing of the alveolus, it is necessary that the base of this triangle has the same vestibule-lingual measure of the alveolus. Then, the flap is positioned and stabilizing sutures are made (Fig 4). This procedure presents high predictability and is particularly interesting for the region of upper premolars.

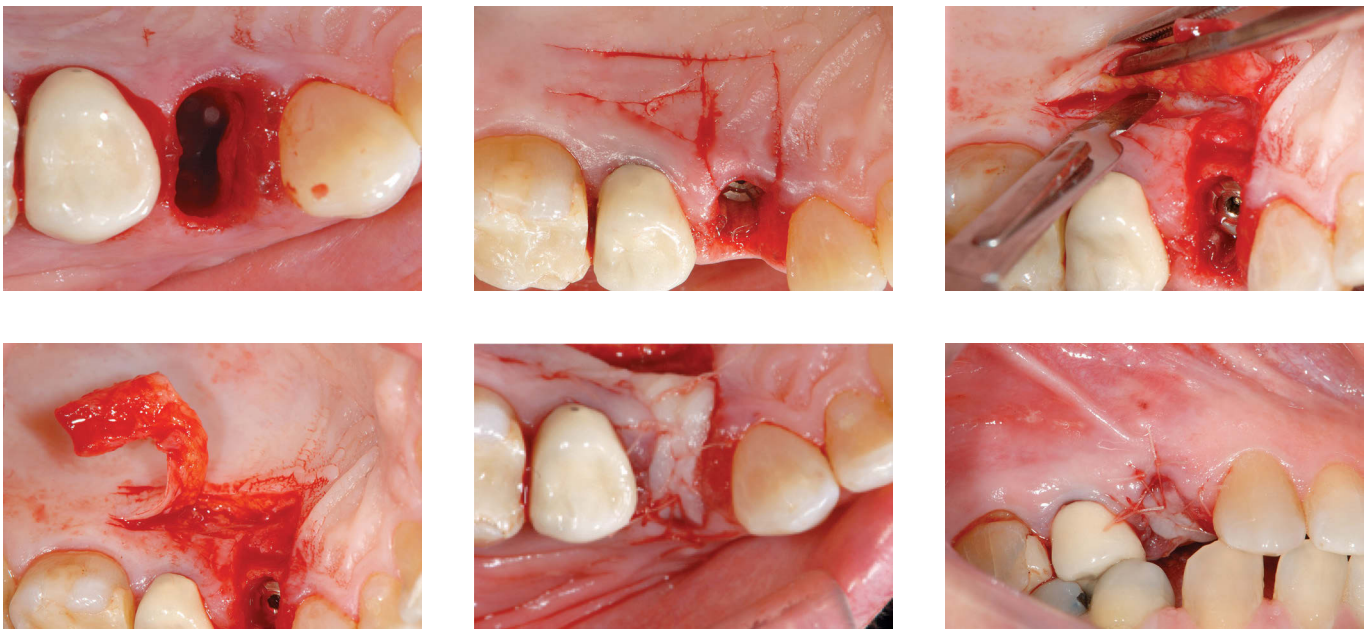

Figure 4 - "L" shaped epithelialized palatal flap.

Split palatal flap

For presenting unfavorable post-operative phase — due to the donor area remaining bloody in epithelized procedures —, Nemcovsky and Artzi[24] proposed a modification in its initial technique.[22] Thus, a full-thickness flap is obtained on the palatal region and split in two parts: an external, containing the epithelium and the superficial portion of the connective tissue; and an internal, containing the deep portion of connective tissue and the periosteum. The internal portion is used to overlay the alveolus, and the external protects the donor area, providing healing by first intention.[9] This technique variation can be used for anterior areas[25] (Fig 5) or posterior regions[26] (Fig 6), to cover alveoli in which implants were installed or in techniques of alveolar preservation. The split flap technique presents some initial degree of difficulty to be performed, overcome by a curve of the short term learning. In clinical practice, a possible criteria of selection among these techniques is based on the variable thickness of the palatal mucosa. In patients where the palatal tissue is thinner, the epithelialized flap is more recommended; while the split flap is recommended to those patients in which the palatal mucosa has thickness of at least 4 mm.[27,28]

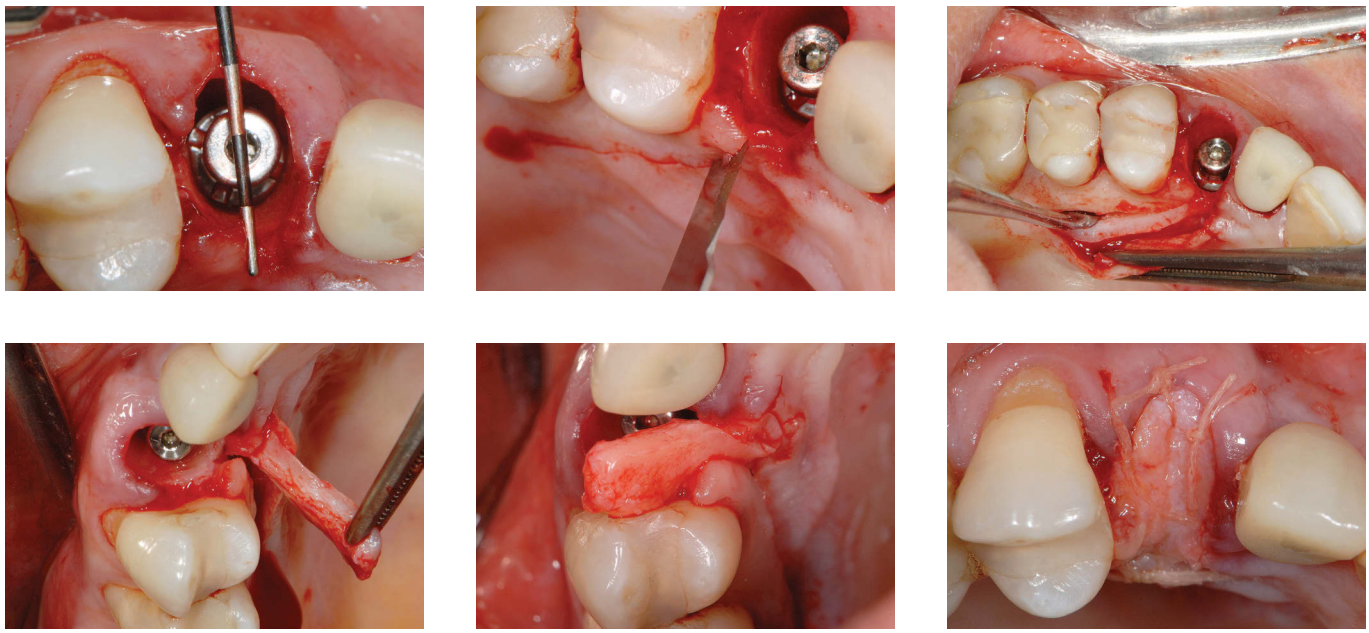

Figure 5 - Anterior split palatal flap.

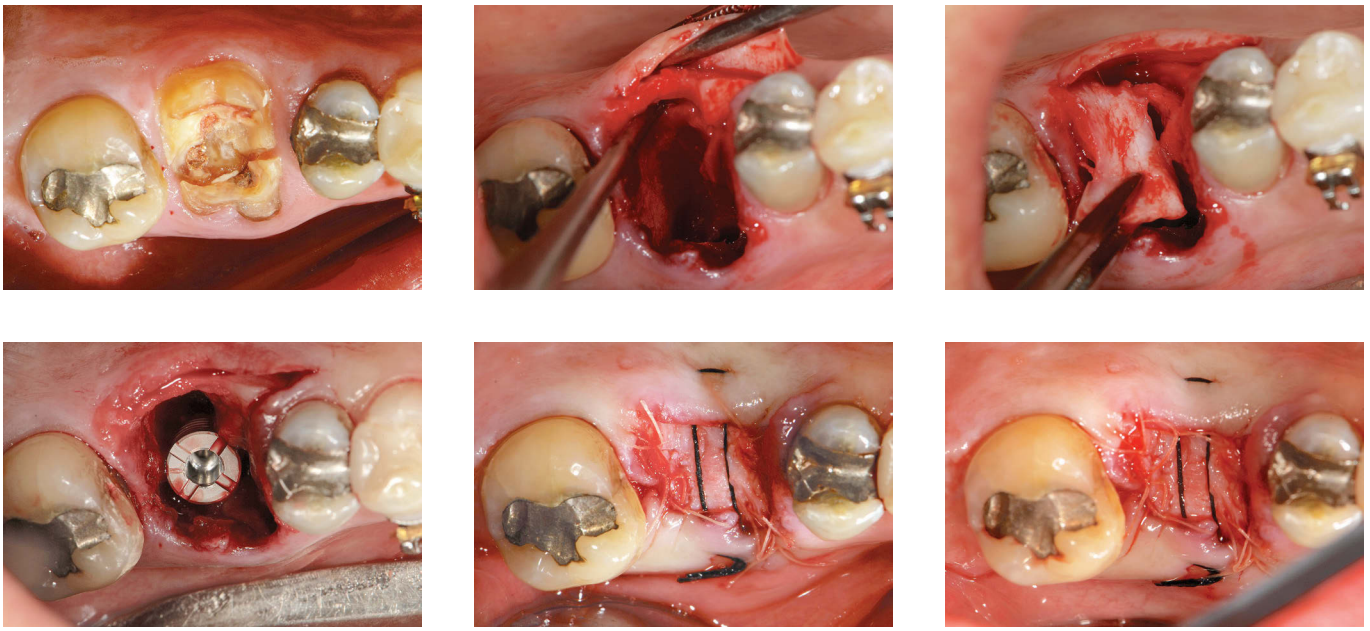

Figure 6 - Posterior split palatal flap.

Granulation tissue rotation

Vascular connective tissue formed on the surface of a wound on healing, of an ulcer or of inflamed tissue. It consists of new capillaries and of an infiltrate containing lymphoid, macrophages and plasma cells. It is possible that after tooth extraction with the elimination of the infectious component, this tissue favor the wound healing, assisting the maintenance or recovery of the gingival contour.[9,29] After the extraction, it must be performed, using a Molt curette, the careful displacement out of the alveolus, of the granulation tissue present on the root apex. This mobilization must not disrupt its connection to gingival tissues. Then it is performed the filling of the alveolar space with collagen matrix. The suture must provide the coaptation of this tissue to the edges of surrounding gingival tissue (Fig 7). Although its recommendation is referenced only in clinical reports,[9,29] the obtained results are promising, and it must be considered as a viable and safe option of alveolar sealing, when there is this possibility — given its low morbidity.

Graft

Segment of tissue placed in contact with an injured area, to repair a flaw, correct a deficiency or to induce the bond between separated tissues (Fig 8).[15] The grafted tissue presents two basic requirements to become viable: to be properly nourished and not move during its incorporation.

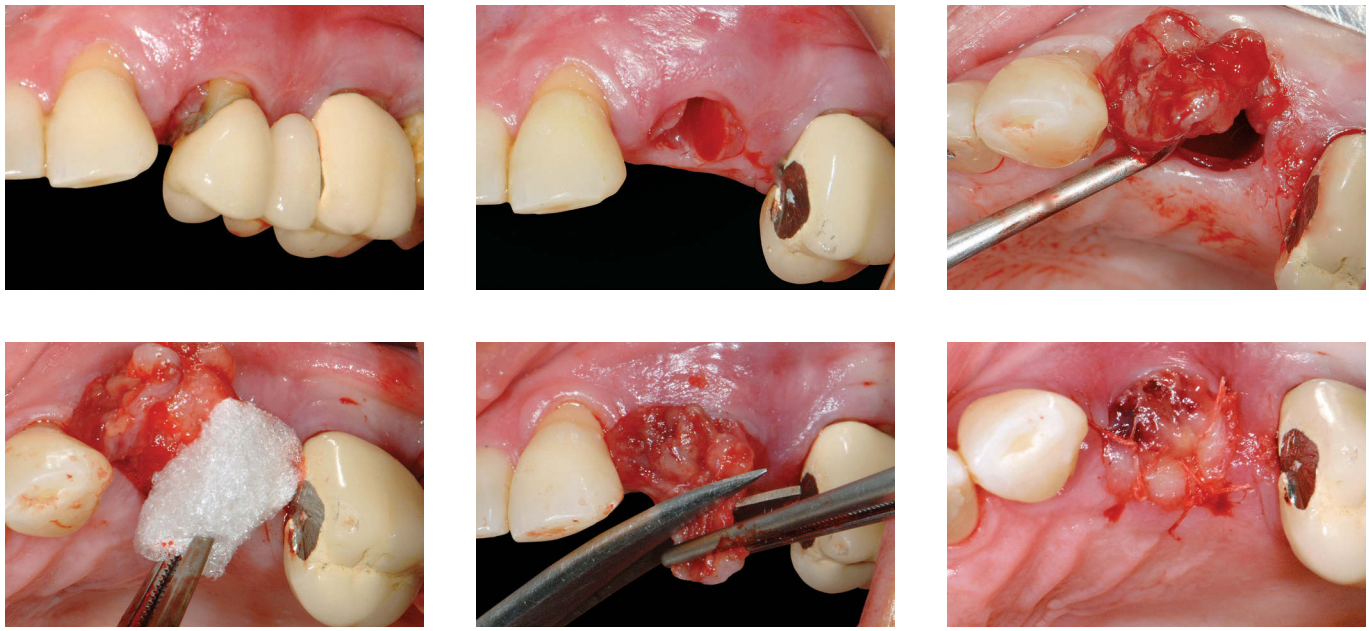

Figure 7 - Granulation tissue rotation.

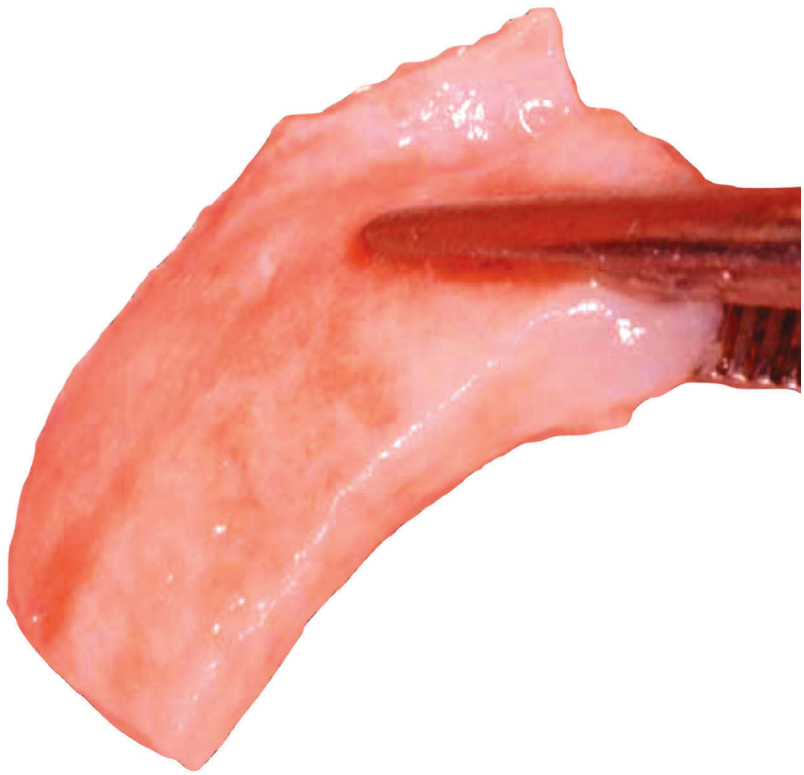

Figure 8 - Graft.

Masticatory mucosal graft

This terminology seems more appropriate than free gingival graft, because it is not the gingival tissue that is grafted, but part of the masticatory mucosa of the palate. It was proposed by Landsberg and Bichacho,[30] in 1994, as part of a technique of alveolus preservation and posterior installation of implant. Some changes were introduced by Landsberg, in 1997[31] and in 2008,[32] as part of the improvement of the original technique.

Thus, the graft dimension is determined by the alveolus perimeter and must be measured preferably on the region of molars and premolars with thickness between 2 and 3 mm, which allows the maintenance of a bone tissue coverage on the donor area. Different ways of stabilization by means of a suture have been proposed (Fig 9).[9] This technique is preferably recommended in procedures of alveolar preservation with normal bone and gingiva architecture,[9] or when the installation of implants in alveolus did not allow the immediate provisionalization of the case.

Barrier

Surgical techniques using barriers — such as the expanded polytetrafluoroethylene, polypropylene (Fig 10), polyglactin, polylactic acid, calcium sulfate and collagen — are used in the belief that the exclusion of the epithelium and of the gingival corium, from the root or existing bone surface, might favor the tissue regeneration.[15] Guided bone regeneration generally refers to bone increase or bone regenerative procedures.[15]

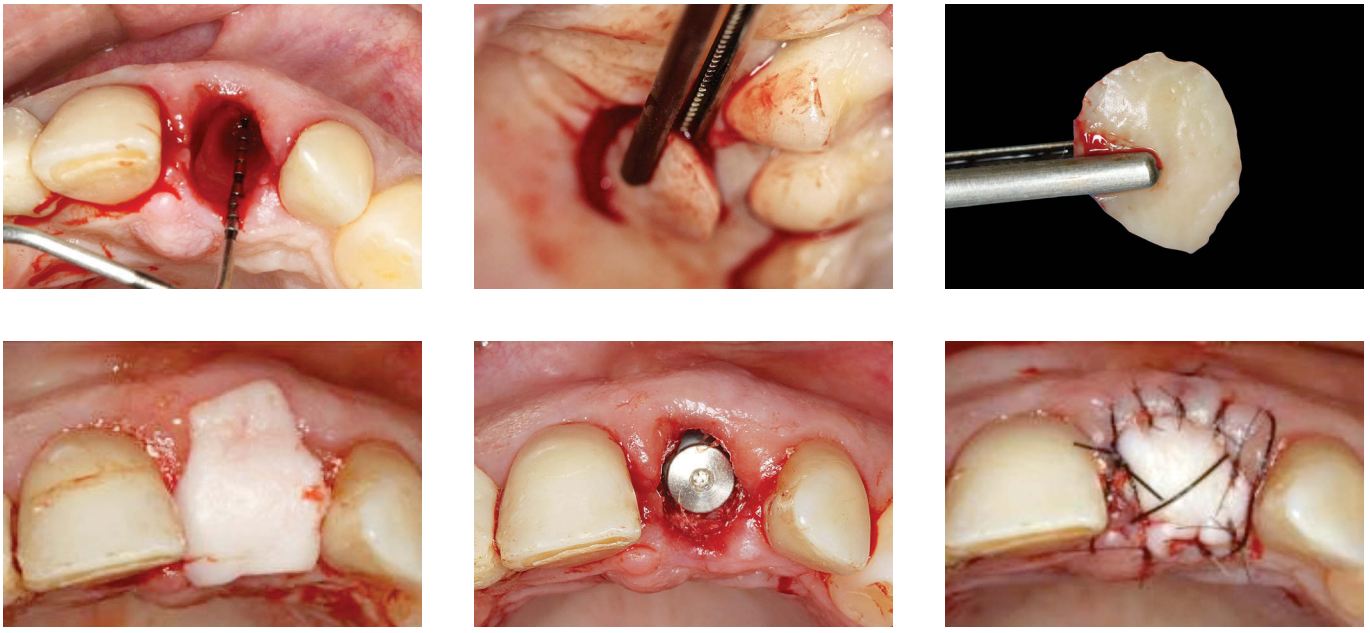

Figure 9 - Masticatory mucosal graft.

Figure 10 - Regeneration barrier.

Alloplastic regeneration barrier

Only some of these materials can be exposed to the oral environment without contaminating and impairing the biological events that culminate with the alveolus bone regeneration.[33] Thus, it must be considered to be used only those materials that do not require mobilization of soft tissue.

Polypropylene

Type of mechanical barrier projected to be intentionally exposed to the oral environment, isolating the area to be regenerated and allowing maintenance of the blood clot in the space comprised of integrate alveolus or bone defect, where pluripotent mesenchymal cells, capable of generating both bone tissue and fibrous tissue, exercise its activities.[34]

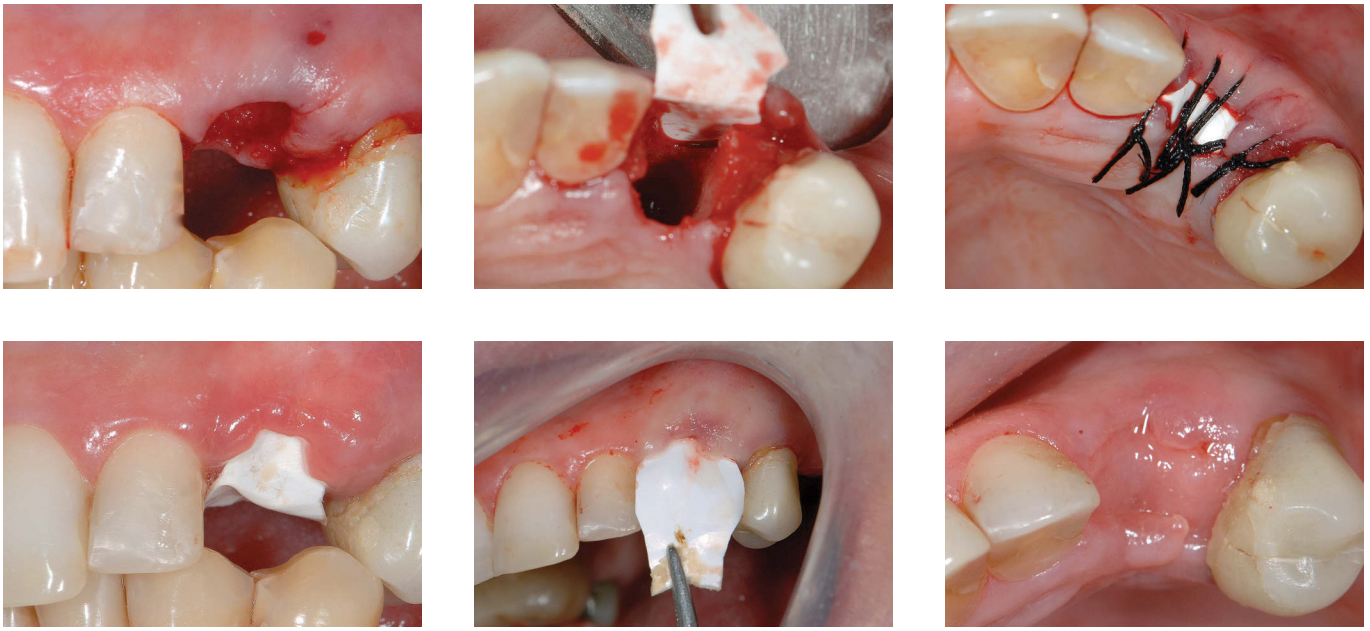

Figure 11 - Polyproprylene regeneration barrier.

Its installation requires minimal manipulation of tissues, just enough to allow the adaptation of the properly cropped barrier, enabling the coverage of the alveolus to be regenerated, which at this moment must be completely filled up with blood. Its use concomitantly to the installation of the implant must allow a space of at least 3 mm between barrier and implant. Its removal must be done between 7 and 10 days after the surgical action even without the complete tissue maturation (Fig 11).

Conclusion

Facing the possibilities for sealing of extraction alveolus, when deciding which technique will be used for each one of the different areas of the mouth — considering the requirements mentioned as from the ideal technique —, the pros and cons must be carefully pondered for the final decision making.

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Where we should analyze bone healing after placement of particulate grafts in surgical bone cavities

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Abstract

The evaluation of particulate biomaterial properties used in surgical bone cavities should take into consideration two different environments: first, the events that occur at the interface between particles, the blood clot and the granulation tissue, including osteogenesis; and second, those that occur in the spaces between particles and away from their surface, that is, induced tissue reactions, including osteogenesis. In these spaces, evaluations should include progressive changes in blood clot, granulation tissue and new bone formation. Responses to particulate biomaterials should be evaluated in face of events directly on the surface of the particles, as well as whether these particles will be reabsorbed or not and be replaced with bone to reestablish normal conditions in the site.

Keywords: Bone healing. Biomaterials. Bone formation.

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The beginning

Bone repair begins as the surgical cavity is filled with a blood clot, which provides a fibrin meshwork as anchorage for neighboring cells that will adhere to the region.

Neighboring cells that adhere to the clot to repair bone come simultaneously from:

1. The endosteum that covers the trabeculae with osteoblasts and pre-osteoblasts organized as a delicate "wall paper" of very thin connective tissue. On the walls of bone surgical cavities, the trabeculae are sectioned, and the marrow spaces are exposed in windows open to the blood clot formed there.
2. The bone marrow, in the form of tissue stem-cells that differentiate into osteoblasts. The marrow spaces between trabeculae are filled with the bone marrow exposed on the surgical walls of the cavity. In the past, these cells were also called undifferentiated mesenchymal cells. The term "osteoprogenitor cells" has been often used to describe these reserve cells found in the bone marrow.
3. The periosteum, when preserved and re-oriented on the bone surface that underwent operation, because it is rich in osteoblasts and pre-osteoblasts, particularly on the internal surface that is in contact with cortical bone.

The formation of a fibrin meshwork: angiogenesis occurs immediately after that

Before the cells permeate the whole fibrin network, a mesh of newly formed vessels has to be constructed to nourish the cells that will reach and invade the whole clot, from the periphery to the center. After some minutes, angiogenesis begins from the neighboring blood vessels, immediately after clot formation: this phenomenon is characterized by new vessel formation. Angiogenic mediators, particularly growth factors, are released by endothelial cells, platelets, macrophages and cells from the injured region.

Granulation tissue: in minutes and hours

Angiogenic mediators, released at the site by platelets and macrophages that originated in clotted blood in the surgical cavity, promote on the vessels of neighboring bone the proliferation of vascular walls cells, such as angioblasts and endothelial cells. Forming sprouts, they all align unidirectionally towards the center of the cavity. This vascular meshwork of newly formed vascular branches and inflammatory cells, particularly macrophages, characterize the first phases of granulation tissue: a fragile, gel-like tissue still poor in fibers and tissue cells. Its name derives from the large amount of small reddish dots that give it a granulated appearance. Doctors in the past, who had no microscopes, said that the wound was granulating, which meant that it was progressing well into full repair.

The term ***granulation tissue*** indicates repair and connective tissue reconstruction, as the last phase of a successful inflammatory process. Granulation tissues should not be confused with chronic inflammation, a phase of inflammation in which the aggressive agent is resistant and difficult to destroy.

Chronic inflammation is a term that indicates that the aggressive agent is persistent, whereas granulation tissue means that the aggressive agent has been controlled and eliminated. Chronic inflammation is characterized by the encapsulation of the aggressive agent in the center of the agglomerate of mono- and multinucleate macrophages, associated or not with other leukocytes, such as lymphocytes. These macrophage agglomerates are known as ***granulomas*** and are typical of chronic inflammation, that is, when the aggressive agent is persistent.

Primary bone: In a few hours and days

At practically the same time, at a small time difference from the cells of the migrating vessels, neighboring tissue cells are also stimulated to proliferate by cytokines and growth factors primarily released by macrophages and platelets.

These young cells, many still not differentiated, migrate into the granulation tissue components to become part of it. Between vessels and anchored to the fibrin meshwork, migrating cells differentiate into osteoblasts and rapidly lay down a collagen matrix ready to be mineralized. Therefore, rudimentary and randomly distributed trabeculae appear in some hours and reconstruct bone a few days later by filling up the cavity, although this bone primarily has almost no function in terms of load bearing.

This newly formed bone that fills up the cavity at first has the same organization and structure as embryonic bone and, therefore, is called primary, embryonic or immature bone. Its main characteristics are: rich cellularity, little mineralization and disorganized random distribution in granulation tissue.

Secondary or mature bone: in a few days

Primary bone trabeculae are found around any surgical cavity after some hours or days. Granulation tissue maturation is a process that occurs from the periphery to the center of the cavity. While primary bone in the periphery has already replaced granulation tissue, areas of the blood clot surrounded by immature granulation tissue remain in the center of the bone cavity. Maturation and surgical cavity filling are centripetal processes.

In some days, primary bone will be gradually reabsorbed in the peripheral area and in areas contacting the margins of the bone cavity, where osteoblasts lay down a collagen matrix that is much more organized and mineralized and with fewer osteocytes inside. These new trabeculae are laid down in an organized way to respond to local functional demands according to the loads that they bear. This more organized and mineralized, but less cellularized bone is named secondary or mature bone.

The size of the bone cavity and the particulate material in the clot

If the surgical cavity is small, the fibrin meshwork is the ideal site for the phenomena aforementioned. In larger cavities, however, the fibrin meshwork collapses, retracts or undergoes dehiscence, which reduces its volume due to loss of surface area. The fibrin meshwork is the matrix for new bone formation: if its volume is reduced, the area of the bone cavity that will be reconstructed is also reduced.

The surgical bone defect may be said to have reached a critical size when bone reconstruction does not occur adequately because of size, as retraction led to dehiscence of the fibrin meshwork, the origin of granulation tissue.

In these cases, one of the options is to increase anchorage of the fibrin meshwork by adding solid particles to it (Fig 1), so that its fixation is increased and extends beyond the surgical margins. Biomaterial particles act as true pillars, or dowels, for provisional and intermediate anchorage for the fibrin meshwork. Examples of particles to be grafted into blood clots in bone cavities are: autogenous bone fragments, bovine bone, polymers and other several options available in the market.

A particulate graft implant in the blood clot preserves the surface of the fibrin meshwork and also reduces the bone spaces to be reconstructed, initially, by granulation tissue originated in the migration of neighboring cells (Fig 1).

Ideal biomaterial properties: neither antigenic, nor foreign body!

Particles should not be toxic or contaminated to ensure that the fibrin meshwork, platelets and macrophages are the first to find anchorage and interact with their surface. Ideally, macrophages, which also recognize foreign substances and are antigen-presenting cells, should not recognize any foreign proteins. Also ideally, macrophages should not recognize particle surfaces or composition as being foreign, so that particles are not treated as foreign bodies or antigenic substances.

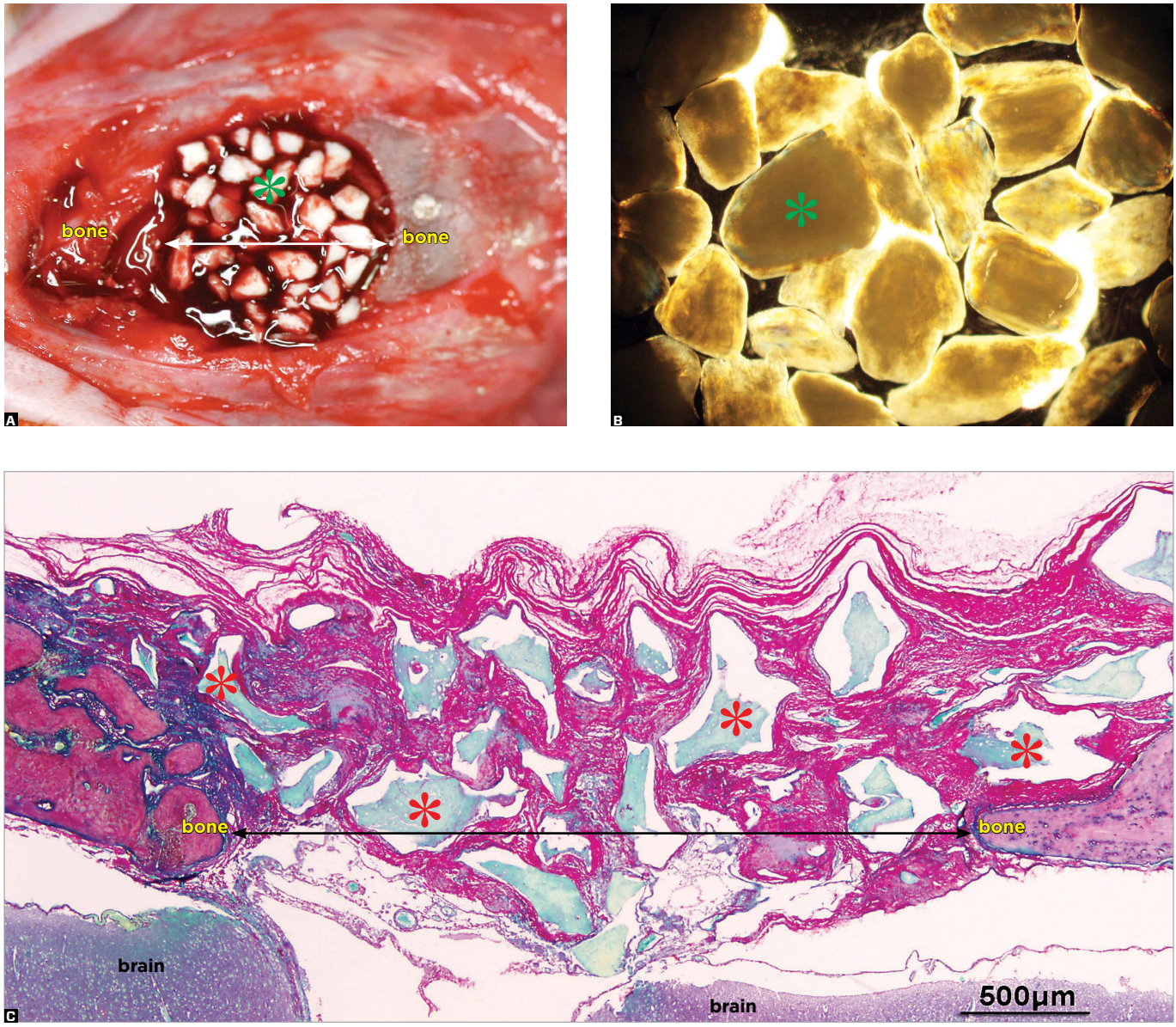


Figure 1 - Spaces between biomaterial particles (asterisks) are initially filled with blood clot (**A**) that turns into granulation tissue in some hours and, in some days, becomes fibrous connective tissue (**C**) or newly formed bone. Bone cavity (arrow) in murine calvarium where particulate biomaterial was placed for experiment (Picrosirius staining, images acquired 60 days after operation).

If no antigens or unusual structure are identified, biomaterial particles act as an inert body over which cells, such as fibroblasts, osteoblasts, cementoblasts and other synthesizing cells, will anchor and lay down an organic matrix to be mineralized. The result would be a true structural and functional integration of newly formed bone and biomaterial particles (Figs 3 and 5).

However, products or biomaterials whose particles are all identified as inert bodies are still rare. Most have particles that are not toxic or contaminated, but macrophages in the blood clot still identifying them as foreign bodies, surround them and remain around them for an indefinite amount of time (Figs 2 and 5). Macrophages surround, adhere to and encapsulate particles in the attempt to isolate them from the rest of the body, forming clusters that are called foreign body granulomas (Figs 2 and 5). In addition to mononucleate macrophages, some younger macrophages join older ones and form multinucleate giant cells of inflammation, or multinucleate macrophages.

In most biomaterial particles used in surgical bone cavities, foreign body granulomas are formed and outlined by a discrete organization of collagen fibers and fibroblasts that surround them. After 30, 60 and 120 days, there will be numerous particles and their corresponding foreign body granulomas in the cavity (Figs 2 and 5).

While in the middle of particles of most biomaterials and their resulting granulomas, the blood clot changes into granulation tissue invaded by osteoblasts, producing primary and, later on, secondary bone (Figs 3 and 4). New bone formation between the particles and granulomas does not occur only when the area has been contaminated or when biomaterials release toxic products that prevent new bone to develop in the neighboring granulation tissue.

When biomaterial particles are inert bodies

The proteins in the structure of biomaterial particles are not identified as an antigen when the particle acts as an inert body, and its surface and structures are recognized, even by macrophages, as the same or as part of the same organism, and adhere to their surface and lay down an organic matrix to be mineralized (Figs 3 and 4). In other words, osteoblasts adhere to their surface, and bone forms over that surface, in continuity to the newly formed

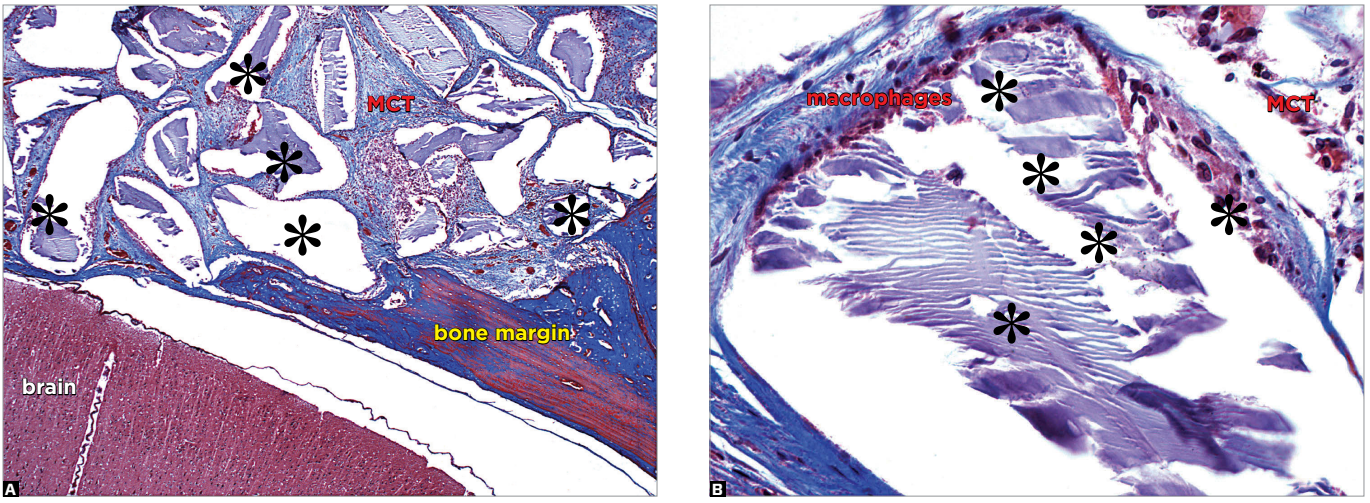


Figure 2 - After some weeks, macrophages and multinucleate giant cells of inflammation adhere to the surface of biomaterial particles (asterisks) and organize as foreign body granulomas to encapsulate particles. Granulation tissue become mature fibrous connective tissue (MCT) in their periphery and in the space between particles and granulation tissue 60 days after operation (Masson's trichrome stain; **A** = 10X; **B** = 25X).

bone in the space between the particles previously occupied by the blood clot and granulation tissue.

Bone formation over biomaterial particles and in continuity to them is a sign of full integration with tissues in the area. After 180 days, bone and remaining biomaterial particles are found in the region. Depending on their composition, particles may be absorbed by osteoclasts and gradually replaced with constantly remodeling bone (Figs 3 and 5).

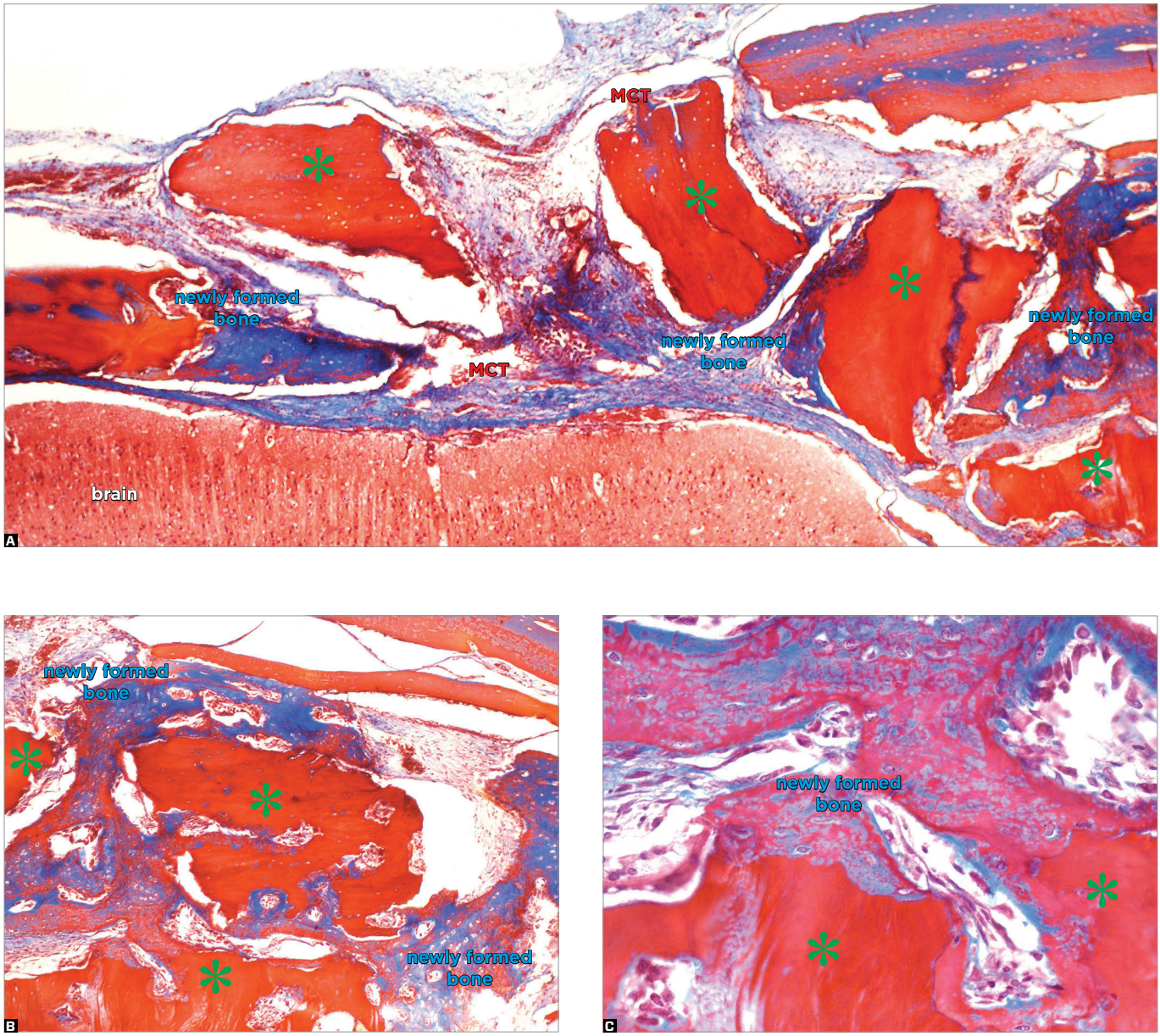


Figure 3 - Tissue sections shows progression of granulation tissue into new bone formation on surface of particles (interface between particle and neighboring tissues undergoing reorganization) and in the space between particles (asterisks). Some biomaterial particles indicate partial resorption and replacement with new bone resulting from bone remodeling 60 days after operation (Masson's trichrome; **A** and **B** = 10X; **C** = 40X.

Biomaterial particles may remain for an indefinite time or disappear

If foreign body granulomas form around biomaterial particles, macrophages are rarely able to phagocyte them, but they never stop trying and remain there indefinitely. No clinical symptoms or discomfort are felt, but there will be obstacles to tooth movement or to place dental osseointegrated implants in the area. Granulomas hardly ever eliminate all biomaterial particles from the site where they were placed originally (Figs 2 and 5).

Some materials accept osteoblast adherence to their surface, and a mineralized bone matrix is laid down, with which the graft becomes integrated (Figs 3 and 5). In this case, as bone is constantly remodeling, the area of bone repair will not be stable indefinitely and will be gradually remodeled.

If osteoclasts can absorb biomaterial particles, the particles will be gradually remodeled and replaced with new bone in the site at the same time as integrated bone. After some months, there will be not even microscopic signs of biomaterial particles at the site. This occurs, for example, with particles of autogenous bone placed in surgical cavities.

Some bovine bone biomaterials have the same properties as autogenous bone, integrate with newly formed bone on their surface and undergo remodeling along months or years. However, other bovine bone biomaterials do not have the same characteristics and behave as foreign bodies, indefinitely forming foreign body granulomas around it and, therefore, remaining in the site indefinitely.

In sum:

1. Some materials increase anchorage of the fibrin meshwork, cooperate with or favor bone formation around their particles and, later on, are absorbed and remodeled together with bone in the region where they were applied.

2. Other materials remain in the implantation site for an indefinite time, even when bone forms over their particles and surfaces. In this case, they do not remodel together with the bone around it because osteoclasts do not absorb them, although they do not form foreign body granulomas around themselves.

3. Most biomaterials leave their particles in the site, which remain encapsulated by foreign body granulomas for an indefinite amount of time, even when bone is formed between the particles. Therefore, there is no clinical discomfort.

When associated with biomaterial particles placed in surgical cavities, there is inflammation with pus, a sign of bacterial contamination. This may be explained by the fact that the material was contaminated or the surgical cavity was invaded by bacteria, usually *staphylococci* and *streptococci*.

What to measure or evaluate in *in vivo* studies about biomaterials

In a surgical cavity where biomaterial particles are used to assist blood clot anchorage, evaluation of effects should take into consideration two "environments," or sites:

1. **The direct particle-tissue interface around it (Fig 5) —** Cells and tissue components in the interface with the surface of biomaterial particles:
   a) may originate from granulation tissue, osteoblasts and mineralized bone matrix that forms directly on its structure; or

b) may form a cluster of macrophages and multinucleate giant cells of inflammation that characterize a foreign body granuloma; or
c) in longitudinal studies, may indicate whether their particles are remodeling together with bone in the region, or whether they are not absorbed by osteoclasts.

2. **The space between particles and their direct tissue reactions (Fig 4)** — Particles and their surface reactions leave a space that was originally filled by the blood clot, later by granulation tissue, and finally by bone. In general, this space is filled with mature bone in a few months.

When foreign body granulomas form around the particles, bone formed in the space between granulomas has a three-dimensional distribution that looks somehow like honeycombs.

In sum, this space should be evaluated to define whether granulation tissue becomes young fibrous connective tissue in some weeks and, right after that, immature and, subsequently, mature bone.

If a biomaterial actively affects tissue reactions in the space between particles, it is probably releasing products during its interaction with cells on its surface, and these products are eventually diffused around it.

These products may be cytokines and growth factors that stimulate osteogenesis or, alternatively, release toxic chemicals that induce inflammation and prevent repair by osteogenesis in this space between particles.

Imaging studies can be performed to evaluate this progression

Imaging studies, such as periapical radiographs, CT scans and micro-CT imaging, may be used to evaluate the following parameters along weeks and months:

1. Persistence, or not, of biomaterial particles when their radiopacity differs from that of the bone where they were placed. Some particles simulate the same radiopacity of normal or newly formed bone, which makes this analysis difficult. Some of the biomaterials are processed bone fragments that retain the same physical properties of bone. Ideally, they should be replaced with bone during remodeling along time.

2. Whether newly formed bone is between particles or in close contact with them on its surface. For those purposes, images should be acquired as very thin micro-CT sections that provide high resolution and clearly show details. However, when doing so, it is not possible to compare microscopic and CT findings, not even when the best scanners are used. When not very mineralized or when still very thin, bone does not generate a detectable image.

3. Bone formation between biomaterial particles placed in a specific site. This test has the same restrictions and limitations described in the item above. Micro-CT sections should be very thin to provide a high level of resolution and show details very clearly. However, it is not possible to compare microscopic and CT findings, not even when the best scanners are used. When not very mineralized or still very thin, bone does not generate a detectable image.

4. Full bone remodeling, as well as particle remodeling, starting at the moment when the same compatible trabecula is seen and in continuity with areas neighboring the surgical cavity.

5. Repair or preservation of bone surface at a desired level, as previously planned.

Shape and size of particles affect results

If the particles adjust to each other in the middle of the blood clot, the space for the clot is reduced (Fig 1). In contrast, if the particles are more distant from each other because of their larger size or irregular shape, the space for the blood clot is larger.

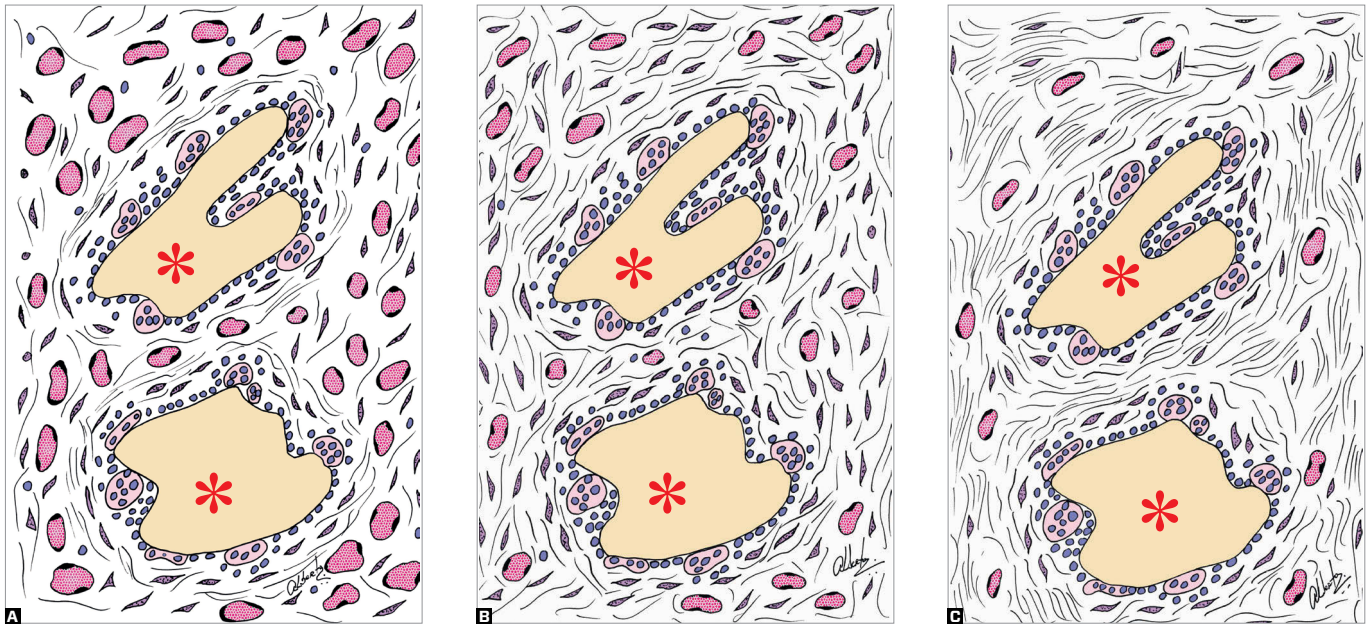
When bone is formed on the surface of particles, osteogenic cells from the granulation tissue originated in the blood clot should adhere to this surface. Particles should not replace all the blood clot and its fibrin meshwork, nor occupy all of its space, and the fibrin meshwork is the true primary matrix for reparative osteogenesis.

A very high density of particles in the blood clot may not be desirable because there may be no space left for the blood clot to reorganize for repair. In other words, pushing down, compressing or condensing particles into the bone cavity may be unfavorable. Ideally, the material should accommodate, fit to, distribute along or adapt to the blood clot and the cavity walls.

Biomaterials in the form of single dense blocks are reparative only in their periphery, as described for each of the particles separately. They behave as a single large particle. When there is only one porous block, full of spaces, as a true sponge, the blood clot permeates all of its structure with the fibrin meshwork, filling them up and serving as a scaffold for repair.

When the biomaterial particles are absorbable and remodel together with newly formed bone, the larger they are, the longer they will remain in place (Fig 5). The clasts act on the periphery and surface of particles. Smaller biomaterial particles, whose granulation is finer, remodel in bone at an earlier stage, if they have that property. When the biomaterial particle is not absorbable, remodeling does not take place, regardless of shape or size.

The variable granulation options that commercial biomaterials have should respond to the different clinical needs in terms of time and repair duration that each case requires in our daily routine. This is directly associated with the type of cell and tissue reaction induced by the biomaterial particles on the surface and between particles.



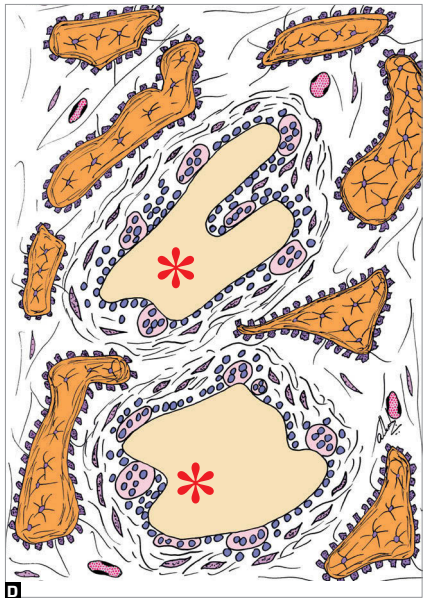


Figure 4 - Morphological tissue and cell changes observed and measured in the evaluation of reactions to particulate biomaterials placed in surgical cavities, particularly in the spaces between particles (asterisks):

In **A**, granulation tissue is immature, has numerous blood vessels (red) and a few fusiform fibroblasts with few collagen fibers (lines). Collagen fibers tend to encapsulate and peripherally isolate particles covered by macrophages and derive multinucleate giant cells of inflammation identified by blue nuclei and pink cytoplasm — in this case organized as a foreign body granuloma.

In **B**, there are fewer blood vessels and more fibroblasts and collagen fibers, and particle encapsulation increased. These are characteristics of mature granulation tissue, which begins production of still immature fibrous connective tissue.

In **C**, there are even fewer blood vessels, more marked collagen fiber bundles organized together with a predominance of fibroblasts, and no inflammatory cells. This condition may remain unchanged for an indefinite amount of time when some biomaterials are used.

In **D**, space between particles may receive neighboring osteoblasts, together with fibroblasts, and start focal new bone formation, which increases gradually as they unite and form large ossification areas, as may occur when some biomaterials are used.

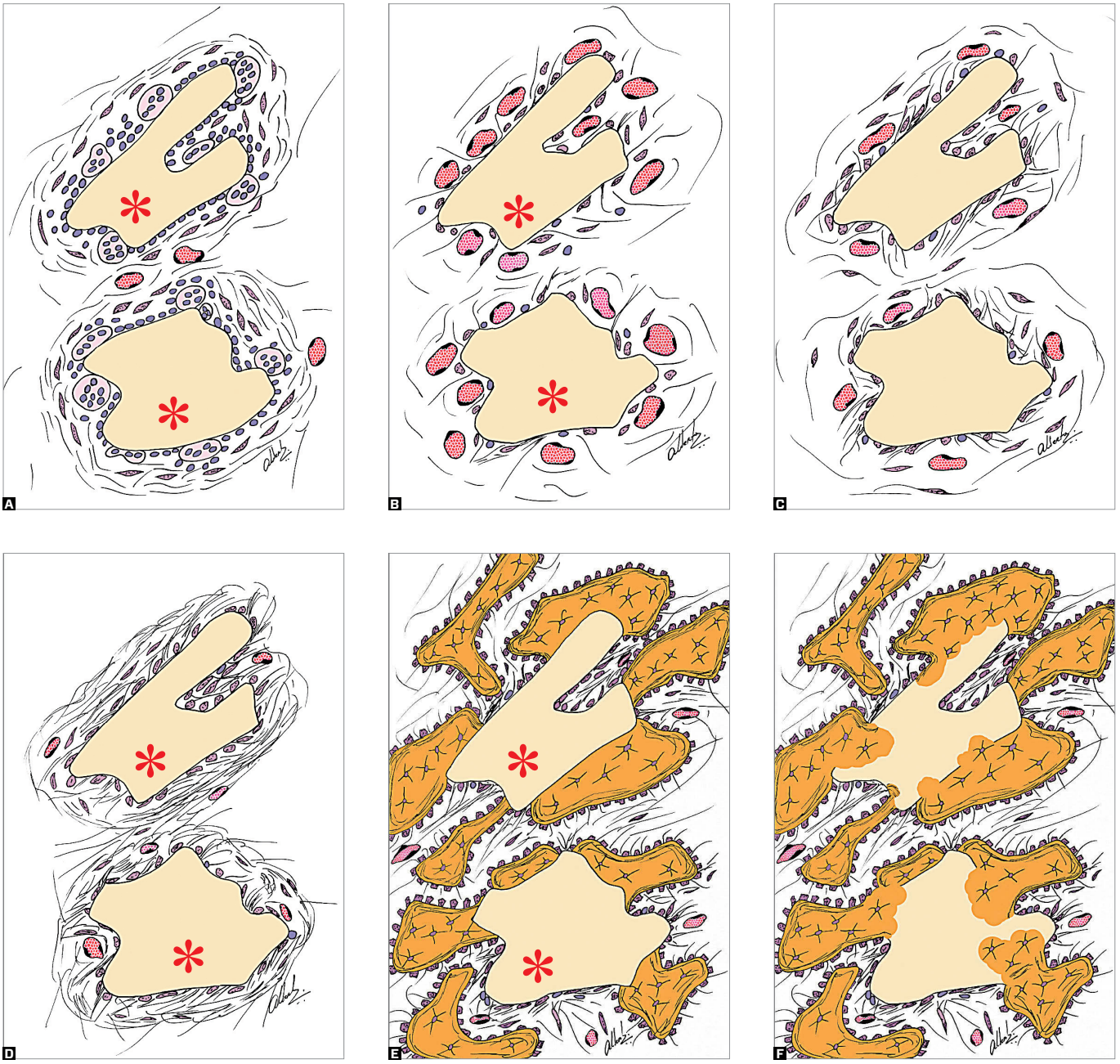


Figure 5 - Morphological tissue and cell changes to be observed and measured in evaluation of reactions to particulate biomaterials placed in surgical cavities, particularly on particles surface (asterisks):

In **A**, foreign body granuloma organizes on surface and immediate periphery of particles of most biomaterials in a few days, being nourished by neighboring blood vessels (red). Macrophages and multinucleate giant cells of inflammation derived from macrophages adhere to particle surface for phagocytosis. This reaction may go on for an indefinite amount of time.

In **B**, on particles surface of some biomaterials, induction to form foreign body granuloma does not occur, and fibroblasts adhere to it to begin production of collagen fibers. In this phase, there are numerous blood vessels and macrophages diffusely distributed between them. At this point, structures organize on particles surface to form immature granulation tissue.

In **C**, there are even fewer blood vessels, more marked collagen fiber bundles organized together with predominant fibroblasts, and no inflammatory cells, which characterizes mature granulation tissue and immature connective tissue.

In **D**, particles integrate to mature fibrous connective tissue that is newly formed, and fibroblasts and collagen fibers are mingled in surface structure. This may remain like that for an indefinite amount of time when some biomaterials are used.

In **E**, as in some biomaterials, neighboring osteoblasts, together with fibroblasts, may adhere to particle surface, which begins new bone formation and gradually increases its area over biomaterial and leads to structural bone-particle integration and formation of large ossification areas, although without biomaterial remodeling.

In **F**, structural bone-particle integration, characterized by large ossification areas, occurs simultaneously with development of focal particle resorption areas and their replacement with bone. Particles are gradually replaced with bone during normal continuous remodeling of human bones.

Final considerations

The evaluation of the properties of particulate biomaterials in surgical bone cavities should take into consideration two different environments.

1) Events, including osteogenesis, that occur directly in the interface between the particles, the blood clot and the granulation tissue.

2) The behavior of the blood clot, granulation tissue and new bone formation in the spaces between the particles distant from their surfaces.

The most preponderant reaction should be associated with what occurs directly on particles surface and whether, along time (weeks and months) the particles will be absorbed to give room to bone that will reestablish normal conditions in the site.

Finally, evaluations should investigate whether biomaterial particles undergo osseointegration or remodeling after some weeks or months. If findings are positive, osseointegrated implants and orthodontic tooth movement may be successfully attempted.

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Medial mandibular flexure related to biomechanical failures of implant-supported fixed prosthesis with rigid connection distal to the mental foramen

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Abstract

Introduction: Some mechanical failures and possible biological problems were related to the medial mandibular flexure in patients who had implant-supported fixed extensive prostheses, with bilateral rigid connection in implants posterior to the mental foramen. **Methods:** Literature research relative to the topic was performed from a query to the MEDLINE database, including papers published from 1954 to 2010. The purpose of this literature review was to compare the possible biomechanical failures of implant-supported prostheses with extension distal to the mental foramen, such as implant fracture, prosthesis screw loosening or fracture, lack of passive fitting of the metallic structure, bone saucerization, and in some cases, muscle pain and limited mouth opening, and to propose a design to these prostheses. **Conclusion:** When the prosthetic planning needs supporting elements at the surface posterior to the mental foramen, the prosthesis should be segmented, especially in the region of the symphyseal area. Thus, the deleterious effects of medial mandibular flexure in the prosthesis and peri-implant area will be minimized.

Keywords: Mandible. Dental prosthesis. Dental implants.

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Introduction

It was performed a literature review of the publications in which the medial mandibular flexure was related to implant-supported fixed prosthesis with rigid connection distal to the mental foramen, aiming at:
1) Suggesting the ideal biomechanics necessary for making this type of prosthesis.
2) Checking the care needed in the casting procedure.

The mandible is a single bone that with the muscle action is able to perform various complex movements. The medial mandibular flexure (MMF) is a deformation of the mandible resulting from these movements performed during normal physiological functions such as talking, chewing, etc. The muscle action during these movements makes both mandibular rami approach. In other words, there is a reduction of the intercondylar distance, mainly by the action of the lateral pterygoid muscle. These variations may be related to lateral pterygoid muscle synergy, the mandible elasticity and the mandibular fossae size of the temporal bone.[1]

The MMF has become an important aspect in dentistry, especially in the field of conventional and over implants prostheses. When the manufacturing of conventional fixed prosthesis has started, as a means of rehabilitating lost teeth, a lot had been studied on this topic, since there was a need, in many cases, to extend the metallic structure to regions distally to the mental foramen when the patient did not agree with the rehabilitation through removable dentures.[2,3]

There are several studies about the possible consequences of bilateral rigid connection with distal extension in conventional prostheses. Some associate MMF with muscle pain, limited mouth opening, absence of prostheses passivity, bone loss, fracture of prosthetic structures, among other complications.[4] With the onset of Implantology, the replacement of fixed dentures in mandible by implant-supported fixed prostheses became a reality and with it the demand to resolve the problem of medial mandibular flexure. So, this literature review aims to analyze the biomechanical aspects of this type of statement, as well as, to assist in proper planning for this type of case.[2,3]

Literature review

Researchers measured the relative movement and the transmission of forces between dental osseointegrated implants in premolar regions of edentulous mandible, by means of a transducer connected to the dental implants. These implants showed deformations up to 420 μm (= 0.42 mm) and a force transmission up to 16 N in mouth opening and 8 N in mouth closing. It was observed that the forces were much smaller in lateral excursions than in opening and protrusion, as a result of the mandible movement from the rest position. While the effects of these phenomena are not known, it was observed that they can be potentially harmful to the interfaces between implants and bone and to the various components of the implant superstructure. The authors of this study reported great variation among individuals and a greater tendency to displacement when the implants were much separated and installed in thin mandibles, especially in the symphysis region. They suggested that this condition can be present in some patterns of implant failure, such as prosthesis screw loosening.[5]

An extensive review of the literature illustrated by clinical cases described nine factors involved in the manufacture of implant-supported fixed prostheses that may promote deleterious effects, including the torsion and medial mandibular flexure. The author points out that the flexure and torsion occur in the mental foramen area, and their magnitudes increase at most distal points to it. The narrowing that occurs can be measured with calipers. It was concluded that the loss

and/or fracture of components and damage to bone can occur by this factor, and for this reason, caution should be taken in choosing the alloy and the design of the prosthesis to be used.[1]

Authors, by means of an in vitro study, tested the hypothesis that medial mandibular flexure influences the distribution of forces in the mandible/implant/superstructure complex. Six Brånemark® implants were placed on a replica of a human edentulous mandible, manufactured with acrylic resin. The applied forces were measured with four resistance extensometer elements mounted on each of the six pillars of standard titanium. The mandible was upheld by its lower border and was suspended in a framework that simulated the natural situation. A gold alloy superstructure was mounted in various combinations with the implants and occlusal loads at different sites. The resulting forces from each transmucosal abutment were measured. The suspended position ("natural") was associated with significant differences in patterns of force transmission in comparison with the replica of the mandible supported on the workbench. The loads were the most widespread, and large extrusion forces were detected, especially when multiple implants remained connected. The MMF is an important factor in the manufacture of dentures supported by implants in the mandible, and casts doubt on the value of impression-taking techniques that do not allow this phenomenon. The clinical implications are that MMF had a significant influence on the force distribution in the implant-host complex, and can increase the tensile forces in abutments supporting the fixed superstructure.[6]

It was analyzed 317 cases of tripodial subperiosteal implants in symphyseal regions and in mandibular angle. It was found that there was no flexibility in the middle portion of the mesostructure, the medial mandibular flexure rate would be greater than at the posterior portion of the implant and the patient could experience pain when performing wide mouth opening. The correction of the problem was made by cutting the middle portion of the mesostructure in the symphysis area thus enabling the medial implant flexure at a level compatible with the mandible, so the patient had immediate relief of symptoms. The flaws with this type of implant were attributed mainly to a mismatch between the posterior medial mandibular flexure and the rigidity of the metallic alloy used.[7]

Authors report an average approximation of 2 to 4 mm of the mandibular condyles and this value varies according to the bone quality, age, sex, and musculature of the patient. Approximately 2% of patients present movements bigger than 4 mm. This yields an approximation of 250 to 1000 micrometers (0.25 to 1 mm) in the gonial angle and 100 to 400 micrometers (0.1 to 0.4 mm) in the first premolar in which movements of mandibular ramus and body have been combined. This has a major influence on the treatment plan of patients being rehabilitated with tripodial subperiosteal implants.[8]

In a study of 30 patients, the author developed an apparatus to measure mandibular flexure, with the oral cavity opened and closed, which was attached to dental implants. The author believes that, due to the lack of Sharpey's fibers, implants transmit entirety to the bone, the medial mandibular flexure. It was found MMF exceeding 1 mm in 10% of patients.[9]

It was conducted a study to measure the mesial convergence, corporal rotation and dorsoventral shear in human mandibles. Measurements were performed using custom manufactured displacement transducers in six edentulous subjects who had been treated with dental implants in the mandible. These were mounted on the most distal mandibular implants on each side, and measurements were made in real time using an Analog/Digital multichannel converter and a personal

computer for data storage and analysis. Measurements were made while the implants were loaded, and the patients performed lateral excursions of the mandible, opening and closing the mouth. The medial convergence was measured as a linear variation in the most distal implant site. The dorsoventral shear was expressed as a relative rotation of the right and left mandibular bodies projected in the median sagittal plane. The corporal rotation was expressed as the relative rotation of the most distal implant. The medial mandibular flexure occurred immediately after mouth opening and was related to the mouth closing and mandibular protrusion forces. Medial convergence of up to 41 μm (0.04 mm) was observed, with corporal rotation values of up to 6° and dorsoventral shear up to 19°. This study clinically demonstrated, for the first time, three different and concurrent patterns involved in functional medial mandibular flexure, namely: Medial convergence, corporal rotation and dorsoventral shear.[10]

Authors reported a possible correlation between the MMF and discomfort experienced by a patient rehabilitated with full-arch implant-supported fixed prostheses. The patient discomfort was reduced after sectioning of the prosthesis into three parts. An prior attempt was made to section only its midline, which partially alleviated the symptoms. The authors concluded that symptoms occurred only in the opening and protrusion; at rest and laterality, there was no pain.[11]

Researchers reported that when an edentulous mandible is rehabilitated with four or more implants united by a screwed metal bar, MMF can cause loosening of the screws and unnecessary stress and deformations on the prosthesis and implants. The authors describe a clinical case with a bilateral rigid connection prosthesis with distal extension presenting undesirable consequences of MMF and conclude that separating the prosthesis in the midline can alleviate these stresses and deformations.[12]

Authors conducted a study to elucidate the effect of the installation of additional implants in the posterior region of the mandible for treating edentulous patients. Fifteen edentulous patients who received implants (Branemark System®, Nobel Biocare, Göteborg, Sweden) were selected and completed one-year follow-up after the installation of fixed prostheses. In seven patients (Group A), four or five implants were placed between mental foramina; and in other eight patients (Group P), one or two implants were installed on each side of the posterior region, in addition to the implants between the foramina. All implants in both groups achieved osseointegration. In Group A, there was no implant loss after loading. However six implants were lost in five patients in Group P within a year after loading. All lost implants were located in the posterior region. To elucidate whether the failure rate of implants in the posterior region of the Group P after loading was particularly high, the failures were also compared with 89 implants which were installed in the posterior region of the mandible to support partial fixed prosthesis during the same period (Group C). The cumulative survival rate for the implants on the Group P was of 60%, while for the Group C implants was of 100%. The MMF, due to mandible movement, was identified as the most likely cause of implants loss.[13]

Researchers discussed the biomechanical effects of medial mandibular flexure in the accumulation of stress in implant-supported fixed restorations. Relative deformations and stress distribution were analyzed in six models of different implant-supported prostheses systems (six or four implants, with or without distal extenders, full-arch or bars dividing it into two independent prostheses) by means of a three-dimensional finite element model of a human edentulous mandible. A significant amount of stress on the most distal implants and lifting of the superstructure in the region of the symphysis arise as a consequence of the medial mandibular flexure.

The analysis of the generated stress distribution by different restorative patterns suggest that a division of the superstructure at the symphysis level significantly restores mandibular natural functional flexure.[14]

An in vitro study was conducted to determine the influence of splinting implants on stress distribution in two different bone-implant experimental models. Models simulated the placement of four implants in the region between foramina and two additional implants in the mental post-foramen region. The stress distribution in each implant was evaluated by applying a static load on the superstructure. Three types of structures were studied: 1) metallic structure supported by all six implants, 2) structure in resin, and 3) metallic structure supported by the four anterior implants and tapered abutments removed from posterior implants. In all types of superstructure, stress was observed in all implants, with a greater magnitude in the posterior implants on full-arches when compared to anterior ones. This stress can be regarded as the cause of failure of a large number of posterior implants, and the authors believe that this stress is caused, in part, by the MMF that would lead to marginal bone loss in implants.[15]

Regarding prosthetic considerations on implant-supported prostheses, a author reported that to compensate the medial mandibular flexure caused by the pterygoid muscle contraction, the prosthesis can be constructed in segments; thus it does not have a rigid structure involving functional bone flexure, which could generate stress and potentially lead to loss of osseointegration and then to failure. The author, in the same year, described a clinical case using these principles.[16]

Through a literature review of *in vivo* studies, it was shown that in the MMF when force opening the mandible, there is a decrease in mandible width. The average amount of U-shaped flexure was 0.1160 mm, and in V-shaped flexure was 0.1864 mm. There was no significant difference in the degree of flexure between gender, selected age and different configurations of the mandibular arch. A minimal mouth opening was observed as ideal for prostheses molding.[17]

It was studied the MMF which is manifested in the midline during nonmasticatory functional movements in edentulous individuals rehabilitated with bilateral dental implants. The authors assembled displacement transducers on implants located in the anterior region, near the midline and measured three movements: Medial convergence, corporal rotation and anteroposterior shear. As results, values from 15 to 42 μm (0.01 to 0.04 mm) were obtained in opening, from 10 to 21 μm (0.01 to 0.02 mm) in laterality and from 18 to 53 μm (0.02 to 0.05 mm) in protrusion, for medial convergence; for corporal rotation values ranged from 0.05 to 0.11 degrees in opening, from 0.03 to 0.08 degrees in laterality and from 0.03 to 0.15 degrees in protrusion; anteroposterior shear ranged from 38 to 93 μm (0.04 to 0.09 mm) in opening, from 28 to 56 μm (0.03 to 0.05 mm) in laterality and from 52 to 103 μm (0.05 to 0.1 mm) in protrusion. They concluded that it is important for the clinician to be aware to these deformations, taking them into account in the design and monitoring of prostheses.[18]

Researchers believe that MMF can affect the stress distribution in implant-supported fixed partial prostheses and, however, this factor has been neglected in most finite element analysis of the mandible. Thus, in order to investigate the effect of two different types of superstructure on the stress distribution in mandibular bone during the flexure caused by the closure, it was created three-dimensional finite element models consisting of mandibular bone, six implants, and of two- or three-piece superstructures. Muscle forces with defined direction and magnitude were exerted on the fixing areas to simulate the molar closure and the incisal closure, situations in which a significant amount of MMF occurs.

The analysis was carried out using von Mises stress values. During molar closure, the two-piece superstructures showed higher stress values. During incisal closure, the three-piece superstructures inhibited more flexure than the two-piece superstructures. The MMF was an important factor in the distribution of stresses in the models, and therefore it should be considered in the planning of implant-supported fixed partial prostheses in the mandible.[3]

Discussion

The mandible, for being part of the stomatognathic system, presents a dynamic of movement.[1] The contraction of muscles during mandibular movements place the mandibular condyles closer to each other, generating stress lines in the region of the chin.[3] Flexure and torsion occur mainly in the area of the mental foramen, and their magnitudes increase for the most distal points.[4] Through photographic comparisons, three different and concurrent patterns involved in functional medial mandibular flexure (medial convergence, corporal rotation and dorsoventral shear) were clinically demonstrated, a fact later confirmed by other authors.[2,16]

The flexure movement occurs not only in the opening and protrusion movement, it also occurs in laterality, retrusion and closing movements, but with less intensity.[6] Other authors also observed that the mandible performs flexure when it is taken to centric relation position, but in an direction opposite to the movement of opening and protrusion, i.e., there is an increase in the width of the dental arch.[9,18]

Among the factors that control the magnitude of this flexure it can be related the age, bone density and muscle strength of the individual, geometric factors of the mandible and face may also be associated.[7] The area of symphysis and the mandibular length are some of these geometric factors. Individuals with lower symphyseal and bone density and larger mandibles tend to have major changes in the width of the arch.[2] Other studies found no relationship between the symphysis dimensions and mandibular deformations, but their authors themselves reported that the number of studied patients was relatively small.[2,8]

According to some authors there is no significant difference in medial mandibular flexure in the maximum opening between men and women, age ranges and different configurations of the mandibular arch.[12,13]

Several authors have attempted to quantify the medial mandibular flexure, and found 0.07 mm for second molars region and 0.03 mm for first premolars region. Others presented mean lateral flexure values of 0.073 mm and mean flexure in mouth opening of 0,093 mm. Some authors showed deformations of up to 420 μm (0.42 mm) and a force transmission of up to 16 N, being 8 N in closing[4,8,9]. Authors reported a mandibular condyles mean approaching of 2 to 4 mm, also claiming that, in approximately 2% of patients this value is greater than 4 mm; as a result it occurs an approximation of 250 to 1000 μm (0.25 to 1 mm) in the gonial angle and 100 to 400 μm (0.1 to 0.4 mm) in the premolars. Other researchers point medial convergence values of up to 41 μm (0.04 mm), corporal rotation up to 6 degrees and dorsoventral shear up to 19 degrees.[10,11]

Due to the high level of medial mandibular flexure that occurs in the mouth opening, as reported in the literature, many authors suggest the castings to be manufacture with the mouth closed as much as possible, for the working models to have dimensions more coincident with MHI or CR. They also noted that if this factor is not respected, deleterious occlusal interferences will occur in the prostheses and consequently to the implant and the adjacent structures to it.[1,15,16]

The medial mandibular flexure may impair rehabilitation with partial removable prostheses, partial fixed prostheses and implant-supported prostheses. Among the potential clinical problems related in literature, it is cited the lack of passive adaptation of prostheses on their supporting

elements, premature contacts and occlusal interferences, fatigue of structures and materials, and micro fractures in the cement film.[4,17,18] In natural teeth, the effects of MMF are compensated by the compressibility of the periodontal ligament, which does not happen in implant-supported prostheses.[1,2] In the case of implants, the problem due to this flexure would be the stress generated in the bone-implant interface and in the structure of the prostheses.[6] MMF has a significant influence on distribution of force on the bone-implant complex and also may increase the stress in posterior abutments which support fixed prostheses.[11] Excessive forces as occlusal overload, prostheses incorrectly designed and adjustment problems could cause osseointegration problems.[4] Additionally, certain systemic disorders, such as osteoporosis, may influence the pattern of mandibular flexure by altering bone mass. This could change the mechanics of patient-implant complex and lead to an overload on the bone-implant interface.[5] Forces generated by the medial flexure in mandibular movements could be involved in some failure patterns in Implantology, including screw loosening, mainly in patients with extremely distant implants and mandibles with reduced symphysis diameter.[11,16]

It is possible to exist a correlation between the medial mandibular flexure and symptoms such as pain and discomfort in patients using rigid implant-supported fixed prostheses.[7,15]

Analyzing the distribution of stresses generated by different restoration patterns it was suggested that a division of the superstructure at the symphysis level significantly restores the natural functional flexure of the mandible.[12,15,17]

Some authors have reported that sectioning the prosthesis in midline is not enough to completely relieve the stresses, since, in a clinical case presented, the division of the prosthesis in the midline only partially relieved the symptoms reported by the patient. They recommend segmenting the prosthesis in three parts, which was enough to eliminate pain presented by the patient in opening and protrusion.[4] Corroborating these findings some authors argued that during the closure of molars, the two-piece superstructures present higher stress values; on the other hand, during incisal closing, the 3-piece superstructures inhibit more the mandibular flexure than the two-piece superstructure.[3,13]

There is, to date, no conclusive evidence on the degree of MMF required to cause clinical problems. Also it is unknown the long-term clinical effect of it in oral rehabilitation. Despite the need for additional studies on the influence of the medial mandibular flexure in prosthetic treatment, it would be prudent to recommend the following procedures according to this literature review: impressions should be taken with the mouth as closed as possible, without protrusion and without application of muscle strength; evaluate the facial type, muscle strength and bone density before planning extensive or rigid bilateral dental prostheses, considering the possibility of not connecting the bilateral posterior segments in selected cases.[6]

Conclusion

Based on the present literature review, it was conclude that:

1. When the prosthetic planning for edentulous mandible allows the placement of supporting elements on the region posterior to mental foramen, the implant-supported fixed prosthesis should be segmented, especially in the mental symphysis region, thus minimizing the deleterious effects of medial mandibular flexure at the prosthesis, the implant and the peri-implant region.

1. Another decisive aspect is the functional impression, which should be performed with the mouth closed as much as possible without protrusion, in an attempt to reduce at the maximum the distortion of the working model and the subsequent prosthesis.

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Celso Fernando Palmieri Jr

24/05/13 - 8h às 9h50 - Assimetrias Faciais: Ortognática

25/05/13 - 14h às 16h40 - Uso do BMP e enxerto autógeno na Implantodontia e Reconstruções Maxilo-Faciais

José Marcio do Amaral

24/05/13 - 10h30 às 12h

Cirurgia ao vivo: Implantes com alta tecnologia

Munir Salomão

24/05/13 - 14h às 15h30 - Regeneração óssea guiada em defeitos extensos após exodontia com barreira intencionalmente exposta ao meio bucal: Mudança de paradigma.

24/05/13 - das 16h às 16h40 - Expansão de rebordos estreitos com inserção simultânea de implantes, sem enxerto ou biomateriais.

Marcos Cesár Pitta

24/05/13 - 16h50 às 17h30

ATM: Quando indicar a cirurgia?

Implantes em regiões estéticas.

André Caroli Rocha

25/05/13 - 8h às 8h50 - Osteonecrose dos Maxilares associada aos Bifosfonatos: prevenção e tratamento.

25/05/13 - 9h às 9h50 - Reabilitação bucal com prótese sobre implantes em pacientes tratados de câncer de boca.

Rafael Antonio de Campos

25/05/13 - 10h30 às 12h

Cirurgia ao vivo: Exodontia 3º molares

Eduardo Mukai

25/05/13 - 16h50 às 17h30

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Agenesis of #12 and #22 treated by means of dental implants

Dario Augusto Oliveira **MIRANDA***
Marcos Barreto **REGIS****

A 14-year-old female patient arrived at the clinic, presenting with agenesis of #12 and #22 teeth. Orthodontic treatment was performed with the purpose of improving esthetics and function. When the patient turned 23, she underwent implant placement surgery. As the area where #12 and #22 teeth were showed ridge resorption, alveolar expansion was performed in order to allow a implant with external hexagon to be placed at the ideal tridimensional position. Connective tissue graft was also performed. Custom abutments and zirconia crowns were made with porcelain application. The photograph shows a 12-year follow-up: dental proportions and the interface between the soft tissue and the prosthesis in the implant region are worth noting.

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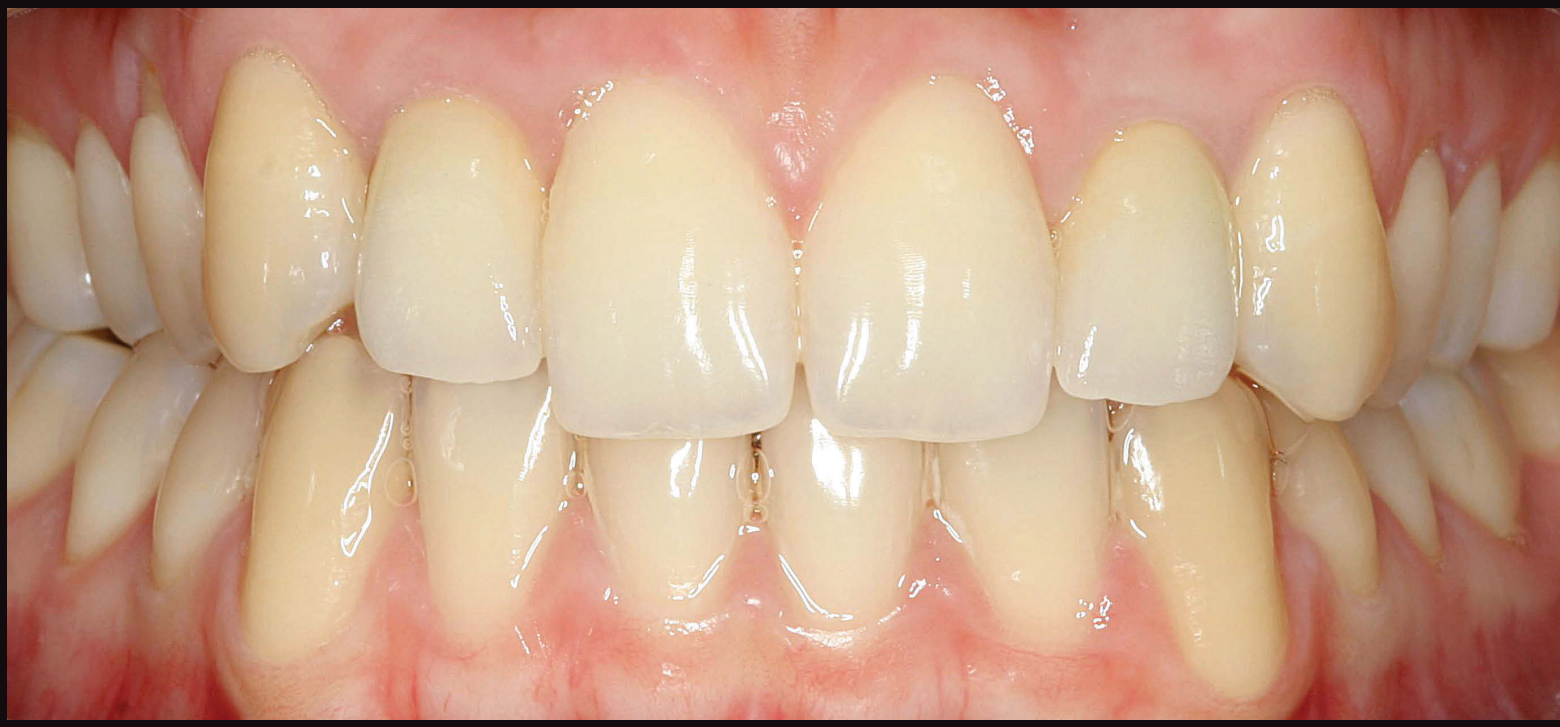

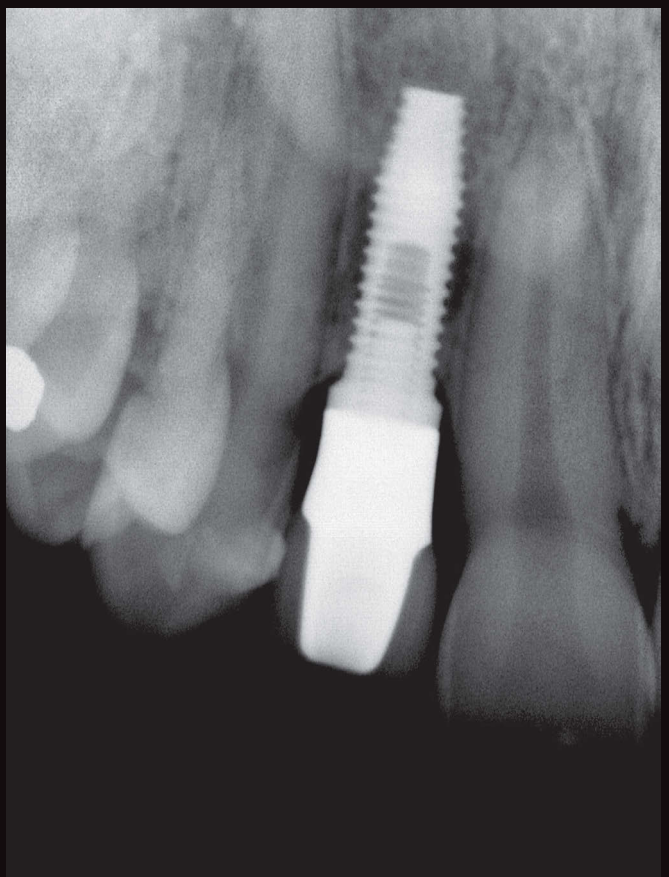

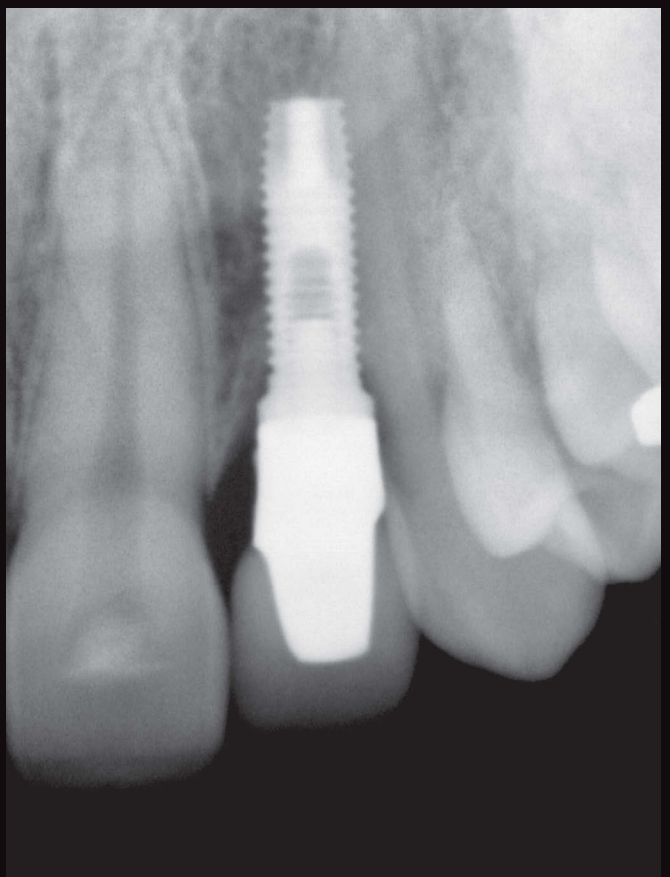

Esthetic excellence in Implantology: The trinomial era

Carlos Eduardo **FRANCISCHONE***
Renato Savi de **CARVALHO****
Carlos Eduardo **FRANCISCHONE JR*****

Introduction

Esthetic advances resulting from the use of dental implants have been some of the major reasons why patients and dentists prefer treatments with implants.

Primarily designed and developed for safe anchorage of prostheses without esthetic concerns, this type of treatment gained larger acceptance when its purpose became the replacement of teeth in areas with great esthetic demands. Recent advances in implant and abutment designs and appearance, as well as the improvement of new ceramic systems, have been fundamental factors in such acceptance. These factors have undoubtedly aggregated esthetic excellence to the treatments with implant-supported prostheses. Therefore, the aim of beautiful prosthetic crowns on adequately placed implants has become feasible and predictable in our daily clinical practice. As a result, the following question is raised: What is the main challenge in implant-supported prosthetic treatments? The answer seems to lie beyond the crown-implant pair.

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Never before in this half a century of osseointegrated implantology supported by scientific findings, so much importance has been assigned to the tissues surrounding the prosthesis[1]. An implant-supported prosthesis may only achieve actual esthetic excellence when in consonance with the gingival tissue that surrounds it.

Tissue response has gained so much importance that it reached the status of "pink esthetics", and the gingiva holds center stage in the triad implant–crown–gingival tissues. Therefore, clinicians should understand that esthetic excellence is now fundamentally defined by this triad, and not anymore by the sole fabrication of beautiful implant-retained ceramic crowns.

Since the importance of gingiva became clear to implantologists, much has been investigated about the safest and most efficient way to handle this tissue. Different approaches may be used to achieve a satisfactory gingival contour. For teaching purposes, they may be divided into those applicable to fresh or healed extraction sockets.

Techniques for gingival contour and emergence profile in implant-supported prostheses

1. Fresh extraction sockets
   - 1.1. Extraction + implant placement + immediate provisional prosthesis.
   - 1.2. Extraction + implant placement (no loading).
   - 1.3. Extraction and contour preservation with provisional prosthesis.

2. Healed sockets
   - 2.1. Successive changes of healing abutments, with progressively larger diameters.
   - 2.2. Successive gingiva compressions by adding resin to the provisional crown.
   - 2.3. Immediate technique for defining gingival contour and emergence profile (Immediate Gingival Conditioning, IGC).

1. Fresh extraction sockets

Item 1.1 should be emphasized because of its importance in terms of timing and opportunity for its performance, as well as the predictability of its results. The placement of an implant and provisional crown immediately after tooth extraction preserves gingival architecture, because the provisional crown supports and maintains gingival shape and contour, and ensures the definition of the margins of the soft tissue until its maturation is complete.[1] To preserve gingival contour and papillae, extraction should be performed with as little trauma as possible and without flap elevation or gingival detachment. This is the best and most predictable clinical procedure to preserve gingival architecture. Two techniques are used most frequently, and the choice is made depending on the presence or absence of the buccal bone plate, which may be assessed immediately after the extraction.

When the buccal bone plate is present, the implant may be placed and immediately followed by the provisional crown. The space between the implant and the socket wall may be filled by a clot, synthetic material, or autogenous bone shavings. If there is no bone plate, an Immediate Dentoalveolar Restoration (IDR)[2] technique should be used.

The absence or loss of the buccal bone plate is associated with length of time from root fracture, or fissure, to surgery. The longer the time interval, the greater the chances of developing inflammation or infection (fistulas, suppuration), which may destroy the underlying bone.

In the IDR technique, bone, gingiva, or both are removed from the tuberosity and implanted in the buccal region where there is no bone plate. In this technique, no incision should be made, nor should a mucogingival flap be elevated before extraction. Figure 1 shows the sequence of steps in this type of procedure.

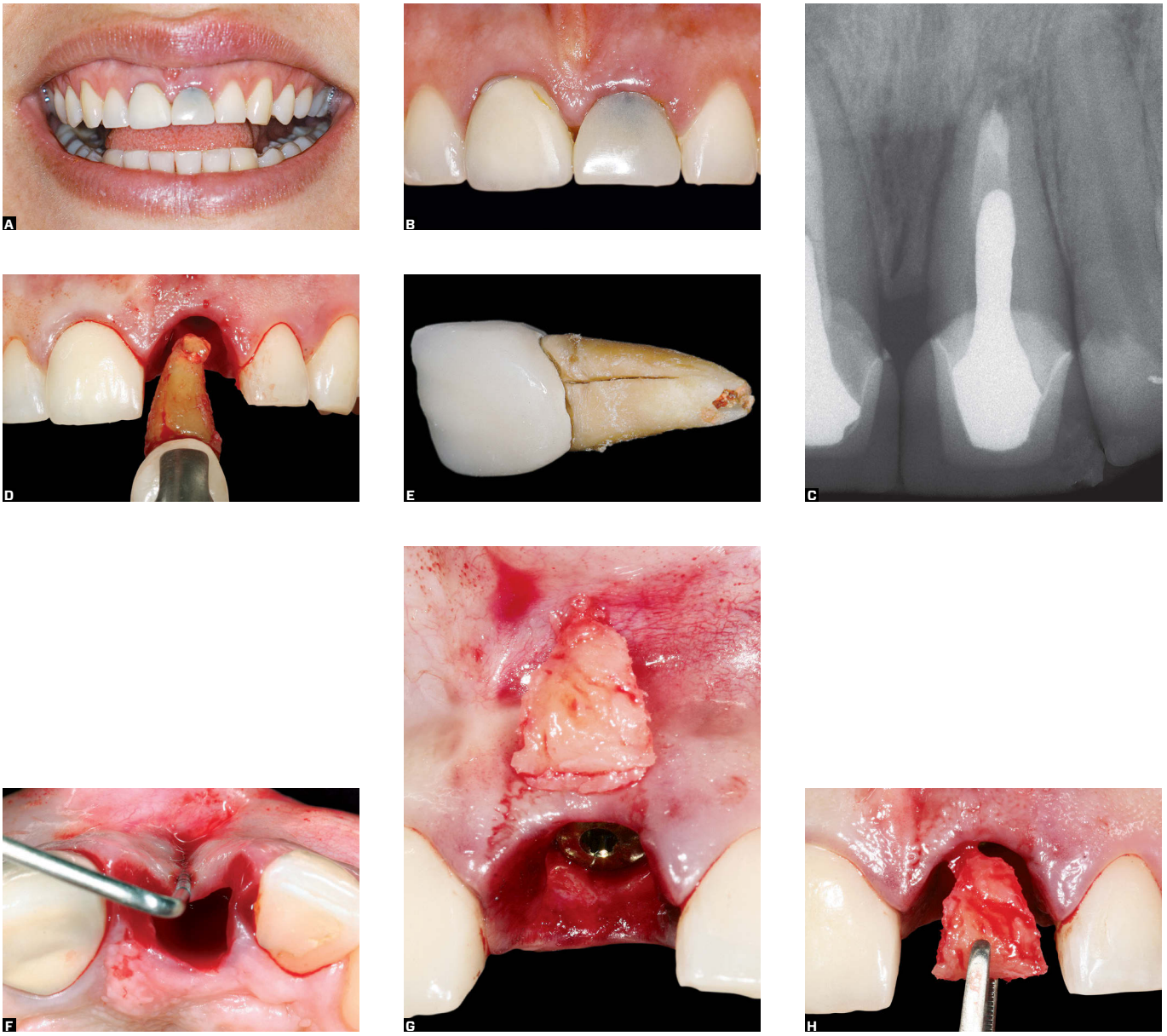

Figure 1 - **A**) View of gingival smile, which poses difficulties to achieving good esthetic results. Clinical probing (tooth 21) revealed root fracture. Figure **B** shows inflammation of marginal gingiva. Patient reported recurring release of crown and cast metal post. **C**) Radiograph of tooth 21 shows discrete apical lesion. **D**) Surgical stage of extraction: at this stage, the purpose is to limit trauma to surrounding tissues to a minimum. **E**) Extracted tooth, with longitudinal root fracture. **F**) Compression of gingiva and loss of buccal bone plate. **G**, **H**) Bone fragment in form of wedge removed from maxillary tuberosity during dimensional checking before grafting.

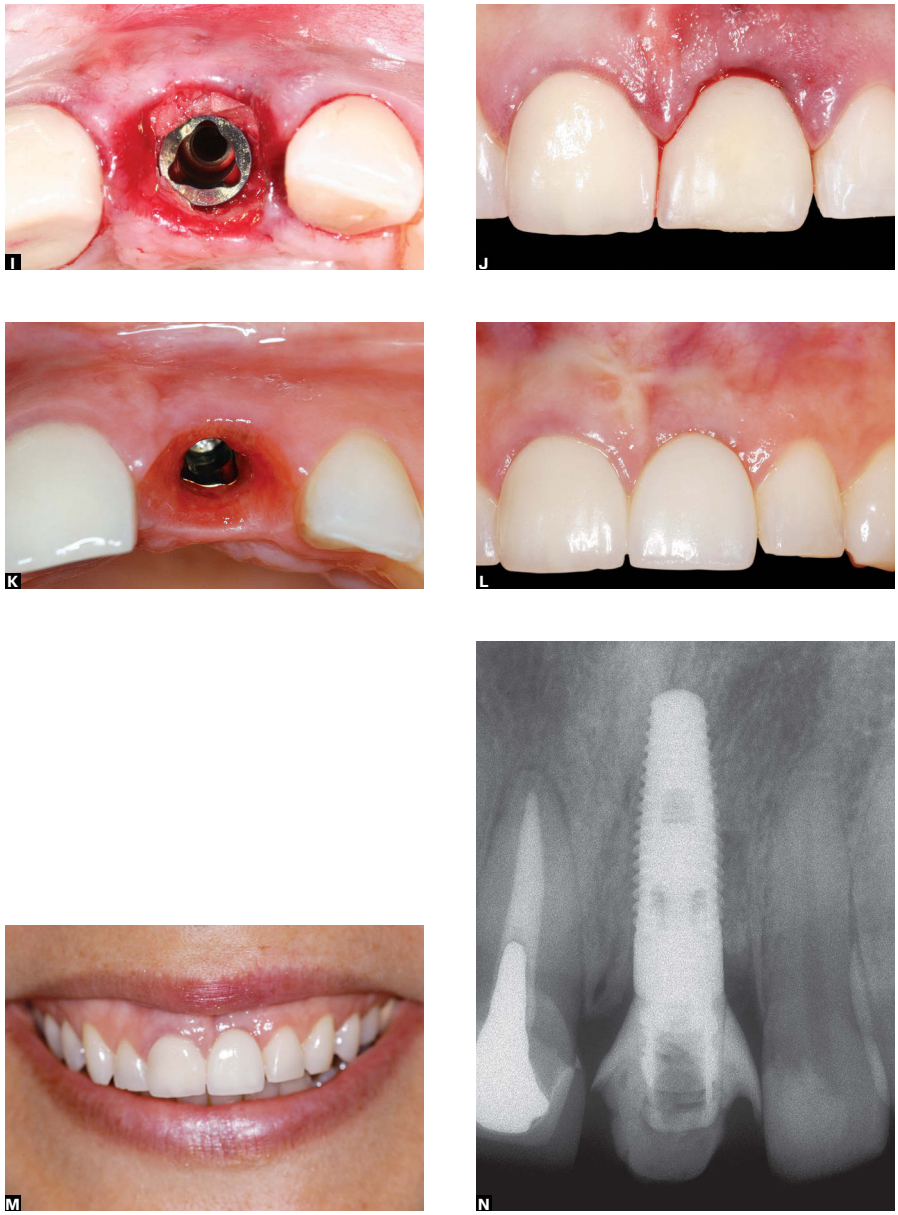

Figure 1 - **I**) Occlusal view shows autogenous graft in place between implant and buccal gingiva tissue. **J**) Provisional restoration screwed over implant. **K**, **L**) Clinical aspect 6 months after implant placement: tissues around crown have a favorable progression. **M**) Final smile with satisfactory transition between crown and gingiva. **N**) Radiograph after placement of prosthetic crown over implant (2 years follow-up).

The provisional crown may be directly screwed to the implant platform or cemented onto a provisional prosthetic abutment. The first one is the better option. For that purpose, the implant should be placed in a slightly lingual position, that is, at the expense of the palatal wall of the extraction socket.

In items 1.2 and 1.3, implants are not immediately loaded, but the same care should be taken during extraction (minimal trauma and no flap). A provisional crown supported by neighboring teeth should be kept in place until the socket heals (item 1.3), or as long as necessary for osseointegration (item 1.2). To preserve gingival contour, the cervical portion of the provisional crown should have the same shape and diameter of the cervical region of the extracted tooth root, and its apical portion should be ovoid and placed partially inside the surgical wound. In addition to preserving and redefining the natural contour of the gingiva, the ovoid shape, slightly adapted to the surgical socket, works as a buffer and contributes to the stability of the blood clot or the filling material placed in the socket.

In 1.2 and 1.3, attention should be paid to maintaining and preserving gingival contour and the papillae, not only at second-stage surgery, but also during implant placement.[3-6]

It should be clear that an extraction, particularly in esthetic areas, should be planned as preparation for the immediate or future placement of an implant.

Even when immediate loading is not possible, gingival shape and contour should be preserved at the expense of provisional crowns supported by neighboring teeth. If such maneuvers are not made at this phase of the treatment, gingival repair will occur freely, and the edentulous ridge will invariably acquire a flat profile (plateau). There may be partial or total loss of the usual gingival contour, as well as loss of papillae characteristics, and the gingiva will have to be repositioned in the future to restore its original shape.

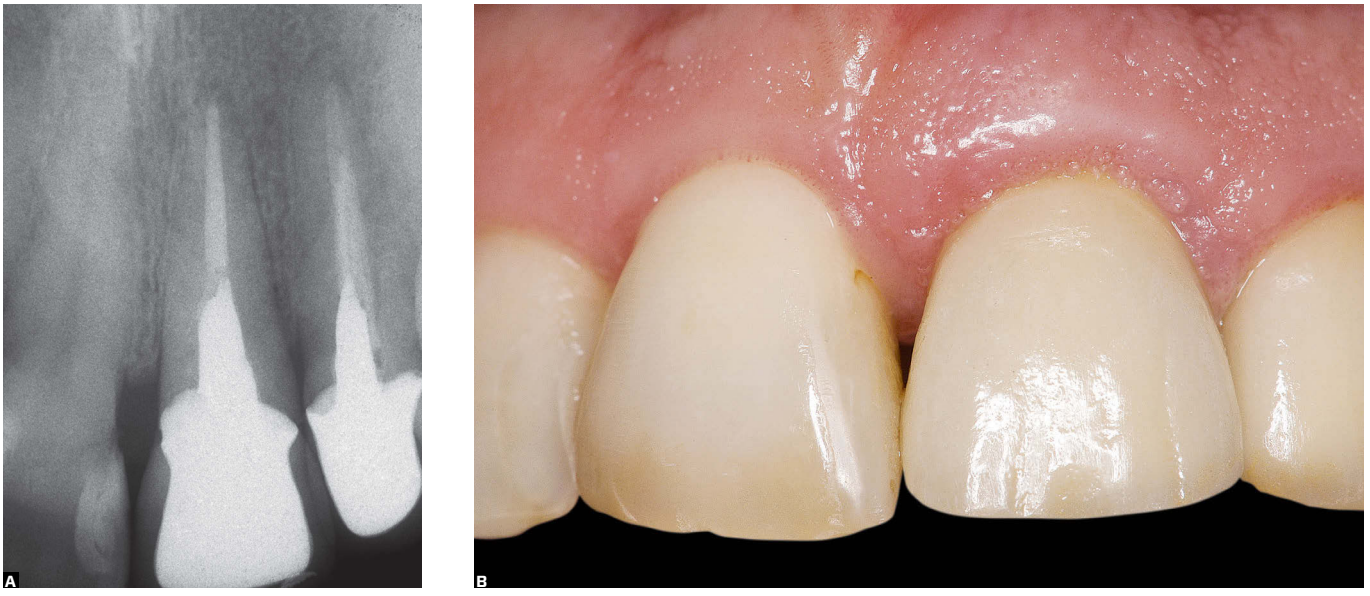

Figure 2 - **A**) Periapical radiograph of tooth 21, with cast metal post and metal-ceramic crown. **B**) Baseline clinical appearance.

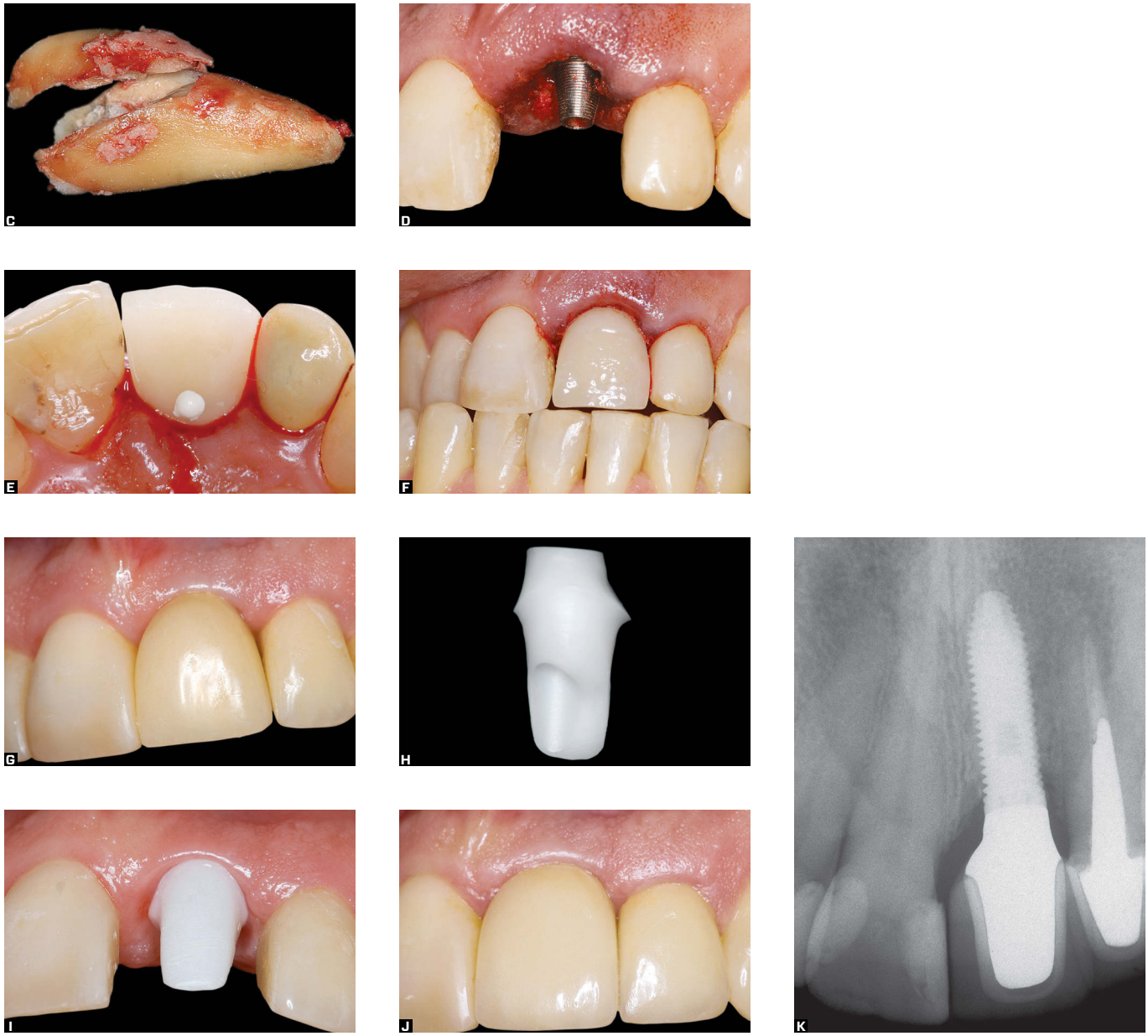

Figure 2 - **C**) Tooth #21 root with fracture, which indicated its extraction. **D**) Temporary abutment over implant. The implant was placed during the appointment for tooth extraction. **E**) Provisional crown placed over temporary abutment. Palatal perforation ensures cement excess extravasation into supragingival area; which is particularly important in cases of implantation in fresh extraction socket, as cement excess may reach deeper peri-implant levels. **F**) Buccal view of crown with adequate gingival support, as well as absence of occlusal contacts in protrusive excursion of mandible. **G**) End of osseointegration phase, with provisional crown and full preservation of usual gingiva contour. **H**) Zirconium abutment for definitive restoration. Concave gingival shape in cervical portion. **I**) Zirconium abutment attached to implant. **J**) Ceramic crown and gingival contour in concave arch shape. **K**) Periapical radiograph shows concave profile of abutment.

2. Healed extraction sockets

Implants in healed sockets demand a different approach from the one used for fresh extraction sockets. In this case, gingival management is essential to reposition the soft tissue according to its original contour. Combined with accurate implant positioning and adequate selection of prosthetic components, these maneuvers play an important role in esthetic success.

To achieve the desired gingival contour, noninvasive techniques, such as the ones described in items 2.1 and 2.2, or minimally invasive techniques, such as the one in item 2.3, should be used.

2.1. Successive changes of healing abutments with progressively larger diameters

This has become a fairly common technique since attention was first paid to esthetics in osseointegration. The successive changes of healing abutments with progressively larger diameters gradually increase the intragingival space, though in a circular form. The shape of the gingival contour should be additionally defined using provisional restorations, often following a sequence as the one presented in the item 2.2.

As an alternative for abutments with successively larger diameters, abutments with a fixed diameter, but a circular cross-section, may be used, with more retention grooves in its body and the addition of acrylic resin. Additions may be repeated every week until the desired gingival separation is achieved (Fig 3). These abutments with resin additions should only be placed on implants after polymerization, contour adaptation and polishing.

2.2. Successive gingival compression using resin additions to the provisional crown

This technique has become a classical step to achieve the desired gingival contour when implants are placed in healed sockets.[7]

Acrylic or composite resin is added to the provisional crown causing gingival compression, which should not produce marked gingival ischemia. Later, compression is reduced, and gingival remodeling is guided by the new contour of the provisional crown. This maneuver may be repeated every week until the ideal gingival contour is achieved. Only after gingival contour has stabilized, impressions of the implant, prosthetic abutment, and gingival contour and profile should be taken (Figs 4 and 5).

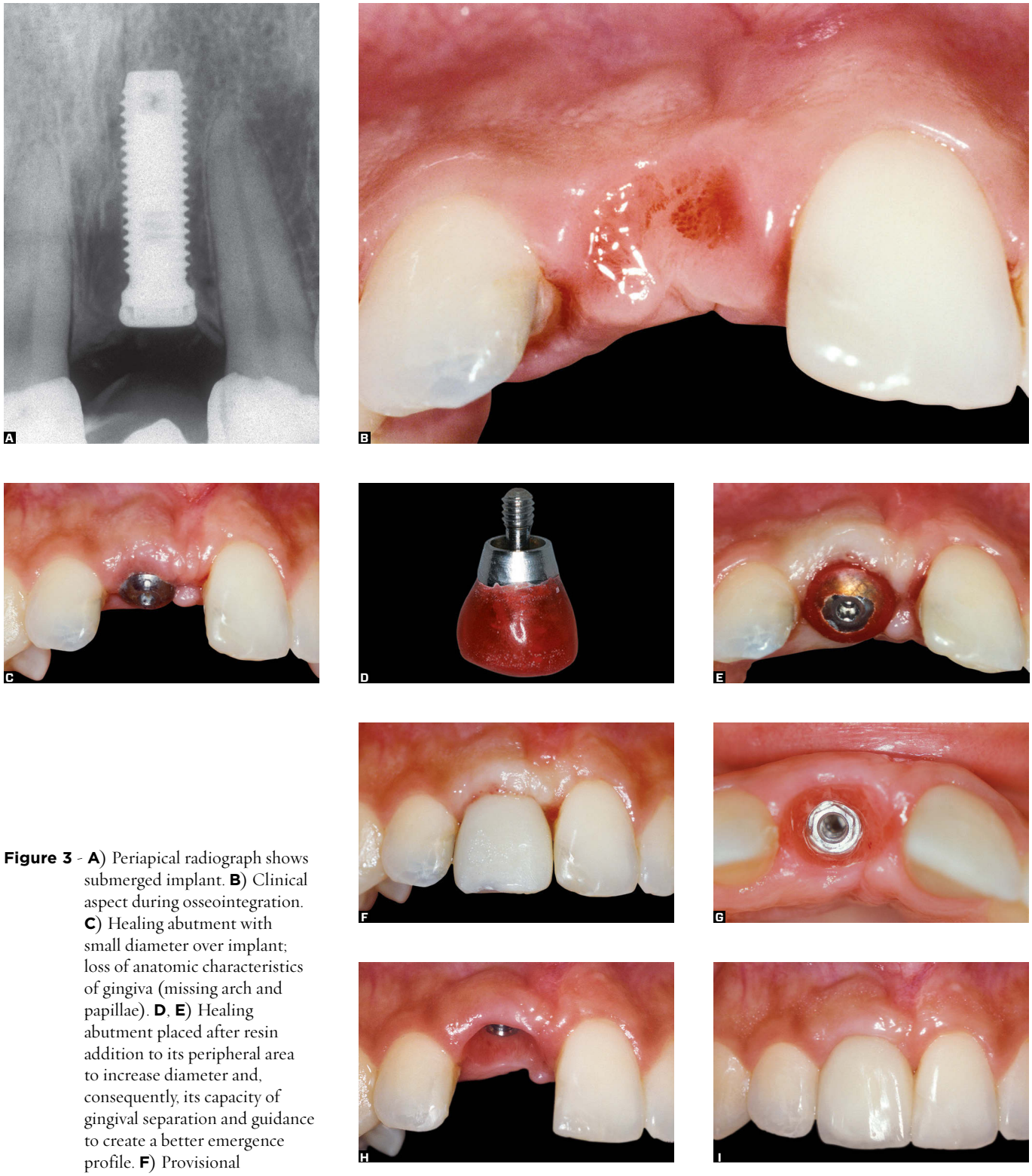

Figure 3 - **A**) Periapical radiograph shows submerged implant. **B**) Clinical aspect during osseointegration. **C**) Healing abutment with small diameter over implant; loss of anatomic characteristics of gingiva (missing arch and papillae). **D**, **E**) Healing abutment placed after resin addition to its peripheral area to increase diameter and, consequently, its capacity of gingival separation and guidance to create a better emergence profile. **F**) Provisional crown replacing healing abutment to refine and complete gingival guidance for esthetic results. **G**) Peri-implant tissue after final recontouring. **H**) Buccal view shows adequate gingival contour and papillae. **I**) Ceramic crown after finishing.

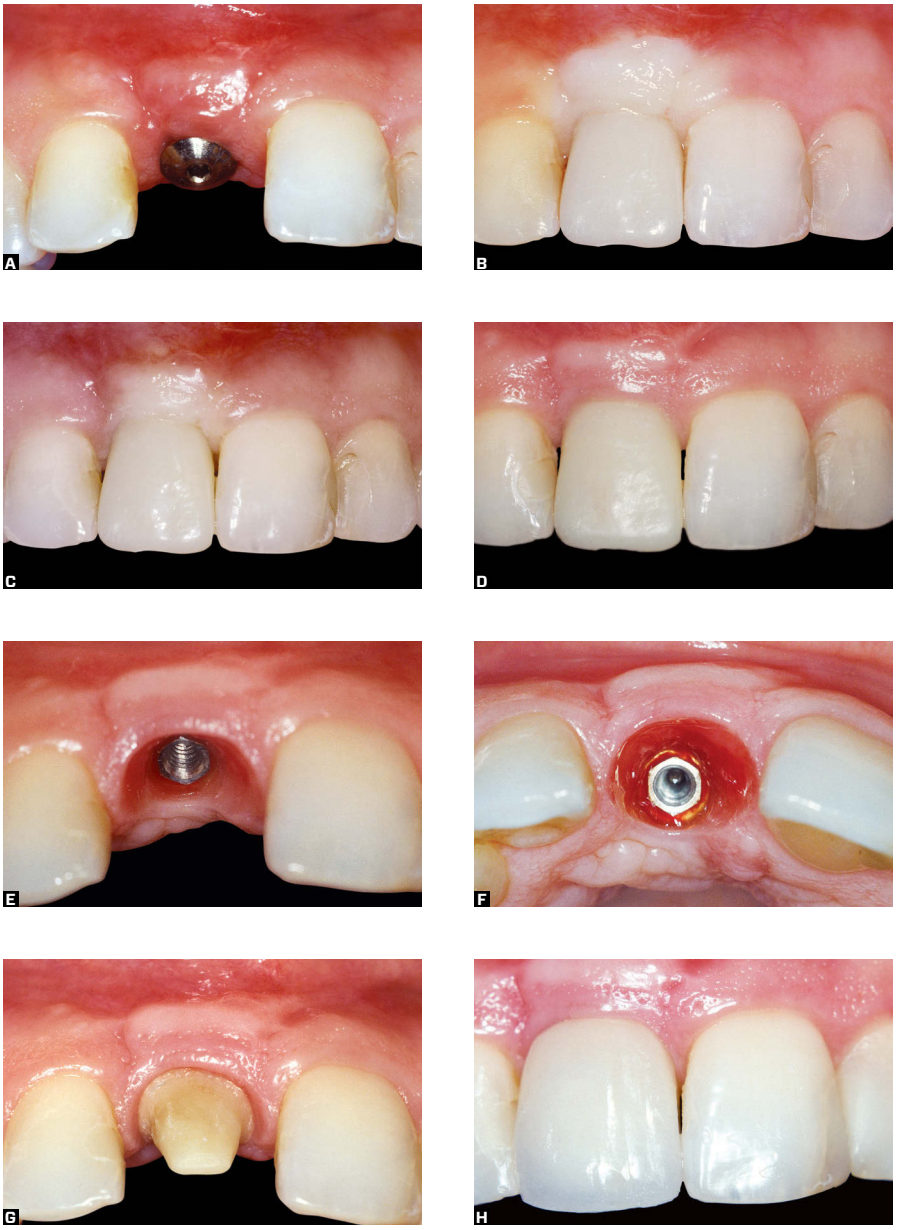

Figure 4 - **A**) Gingival tissue after placement of healing abutment. **B**) Beginning of tissue compression (ischemia) to guide gingiva and achieve esthetic results. **C**) Second phase of gingival guiding and new tissue compression at about one week after first compression. **D**) Final recontouring result. **E**, **F**) Positive aspect of peri-implant soft tissue: adequate emergence profile and gingival contour, and clear papillae margins. **G**) Prosthetic alumina abutment. **H**) Finished ceramic crown shows excellent transition from surrounding gingiva.

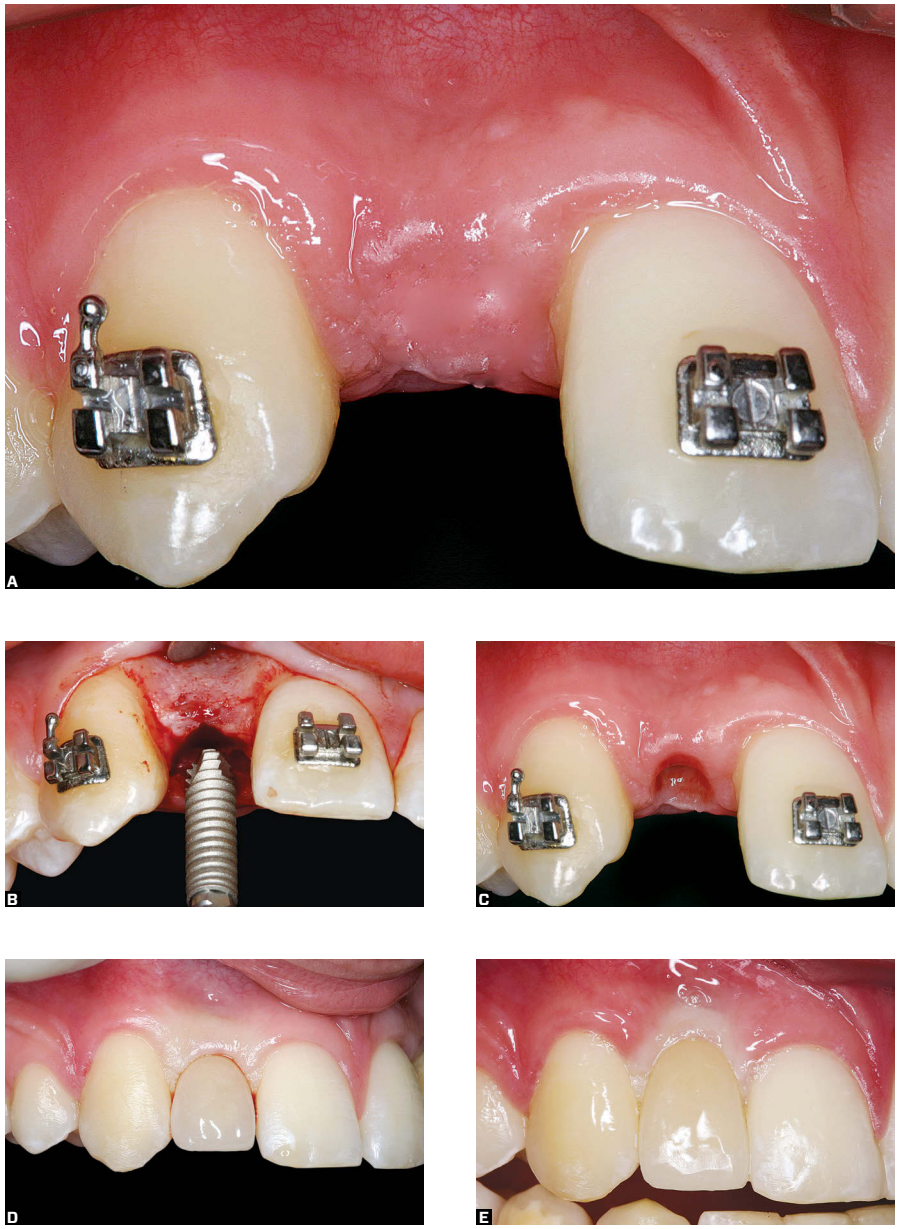

Figure 5 - **A**) Tooth #12 agenesis. **B**) Surgery to place an implant in tooth #12 region. **C**) Clinical aspect of gingiva after removal of healing abutment; implant osseointegration was complete. Although healthy, case completion will demand gingival recontouring to optimize esthetic results. **B**) Beginning of tissue compression (ischemia) to guide gingiva and achieve esthetic results. **E**) Second session of gingival guiding. Successive compressions favor reestablishment of regular gingival contour.

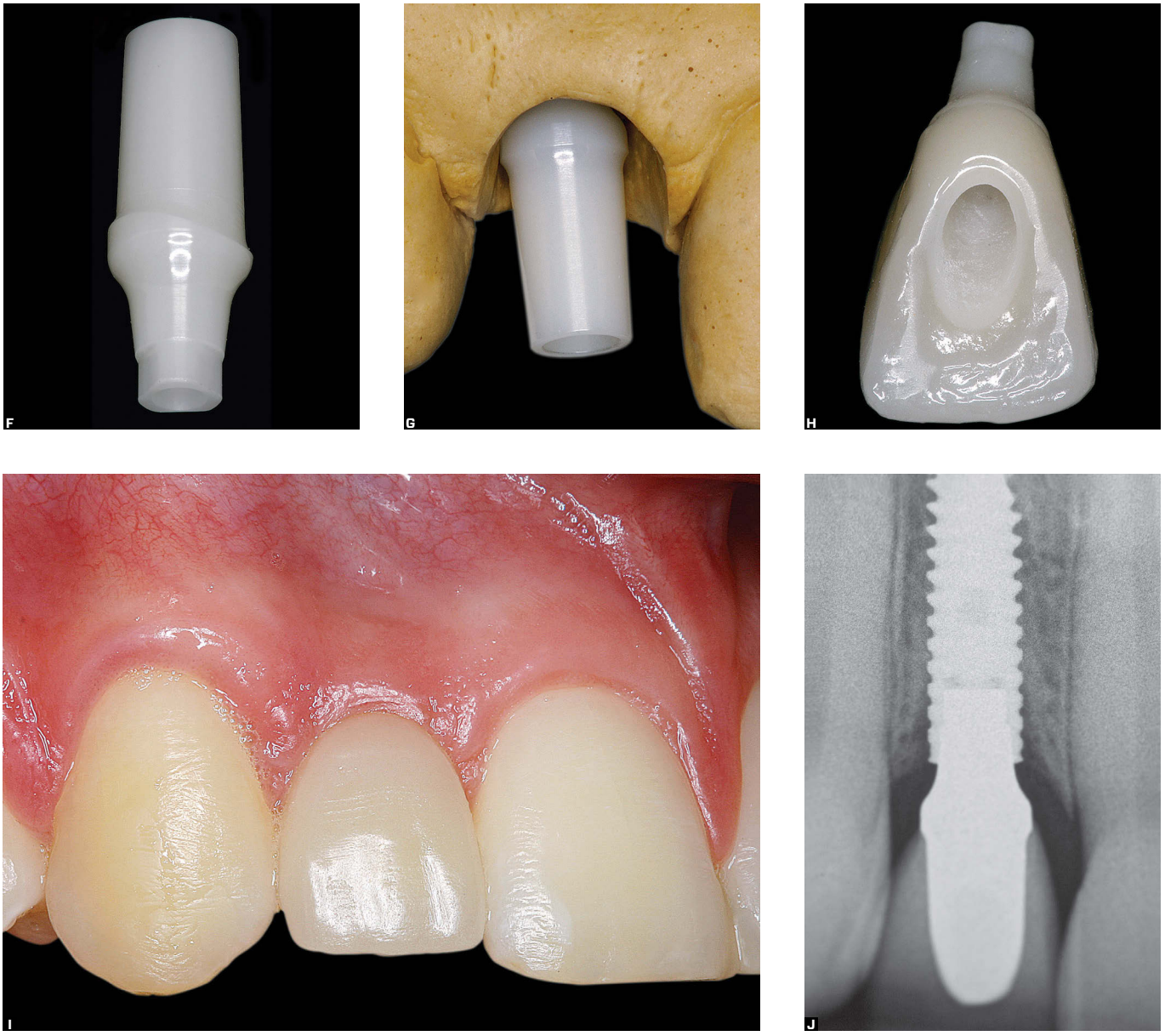

Figure 5 - **F**) Zirconium abutment. Abutment adapted to cast (**G**) and covered with porcelain (**H**). **I**) Ceramic crown screwed to implant; satisfactory transition from surrounding gingiva. **J**) Radiograph shows satisfactory progression of peri-cervical bone and prosthetic abutment with biological concave profile. Clinical and radiographic control at 2 years.

2.3. Immediate technique to obtain gingival contour and emergence profile (Immediate Gingival Conditioning - IGC)

The technique

To achieve the best esthetic results, volume and shape of peri-implant tissues must be harmonious. The gingiva should cover the implanted crown according to previously established esthetic parameters, as regular concave contour, aligned with that of adjacent natural teeth.

The absence or shortage of gingival tissue has been a matter of concern for those who work with implants. During the initial phases of treatment, substantial gingival volume gain should be sought, so that the gingiva can be recontoured in subsequent phases of the treatment, particularly by means of repeated compressive maneuvers. This procedure is satisfactory, although it takes time to complete and achieve successful results.

As an alternative, we suggest a new Immediate Gingival Conditioning (IGC) technique, which consists of a single conservative gingivoplasty. This maneuver is performed using diamond-coated tips of different grain sizes or zirconium tips (Fig 6). Diamond-coated tips should be used at high speed under proper cooling. In contrast, zirconium tips may be used without cooling, which provides better visualization to "sculpt" the gingiva and reduces bleeding to a minimum. Infiltration anesthesia should be used for these procedures. In some cases, when gingival "sculpture" affects a very small area, the procedure may be performed under topical anesthesia, or even with no anesthesia. Its purpose is to remove a very small superficial portion of the gingiva, which results in the creation of the gingival contour and emergence profile without any extra sessions or tissue compression (Figs 7 and 8).

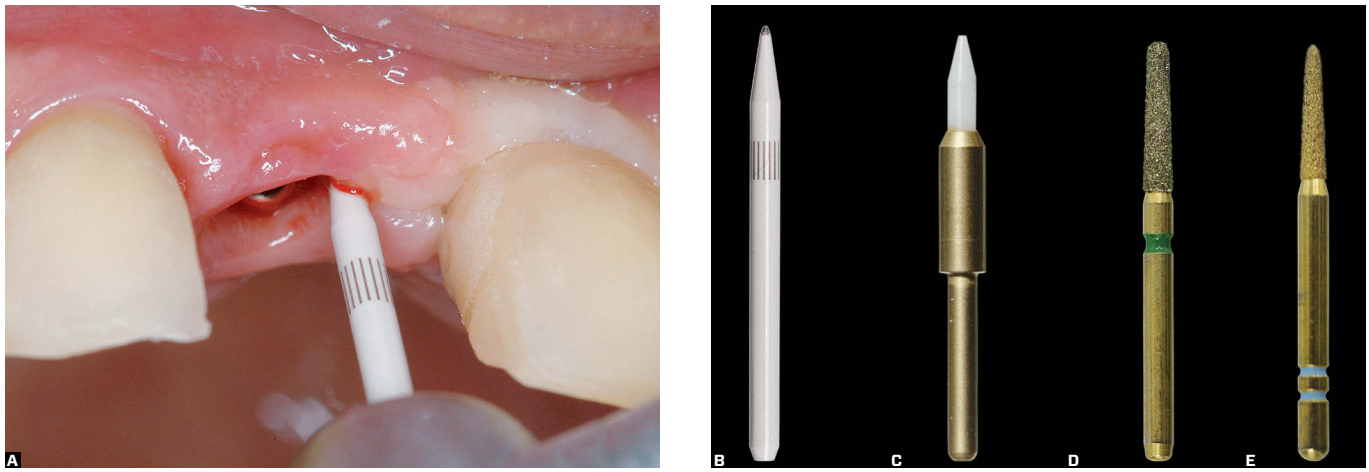

Figure 6 - **A**) Zirconium tip operated at high speed to prepare gingiva in concave arch shape. Zirconium (**B**, **C**) and diamond-coated (**D**, **E**) tips for gingivoplasty.

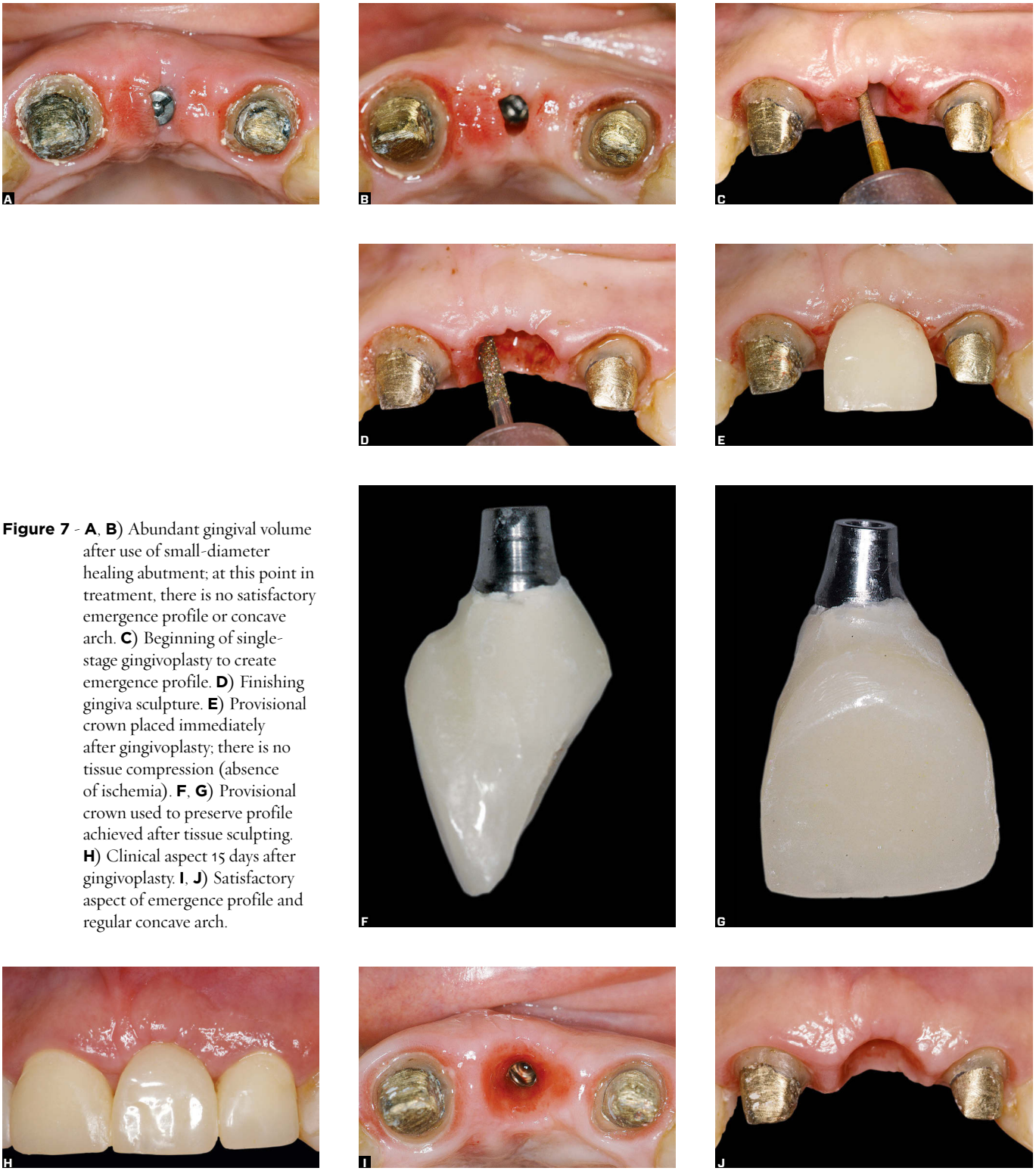

Figure 7 - **A**, **B**) Abundant gingival volume after use of small-diameter healing abutment; at this point in treatment, there is no satisfactory emergence profile or concave arch. **C**) Beginning of single-stage gingivoplasty to create emergence profile. **D**) Finishing gingiva sculpture. **E**) Provisional crown placed immediately after gingivoplasty; there is no tissue compression (absence of ischemia). **F**, **G**) Provisional crown used to preserve profile achieved after tissue sculpting. **H**) Clinical aspect 15 days after gingivoplasty. **I**, **J**) Satisfactory aspect of emergence profile and regular concave arch.

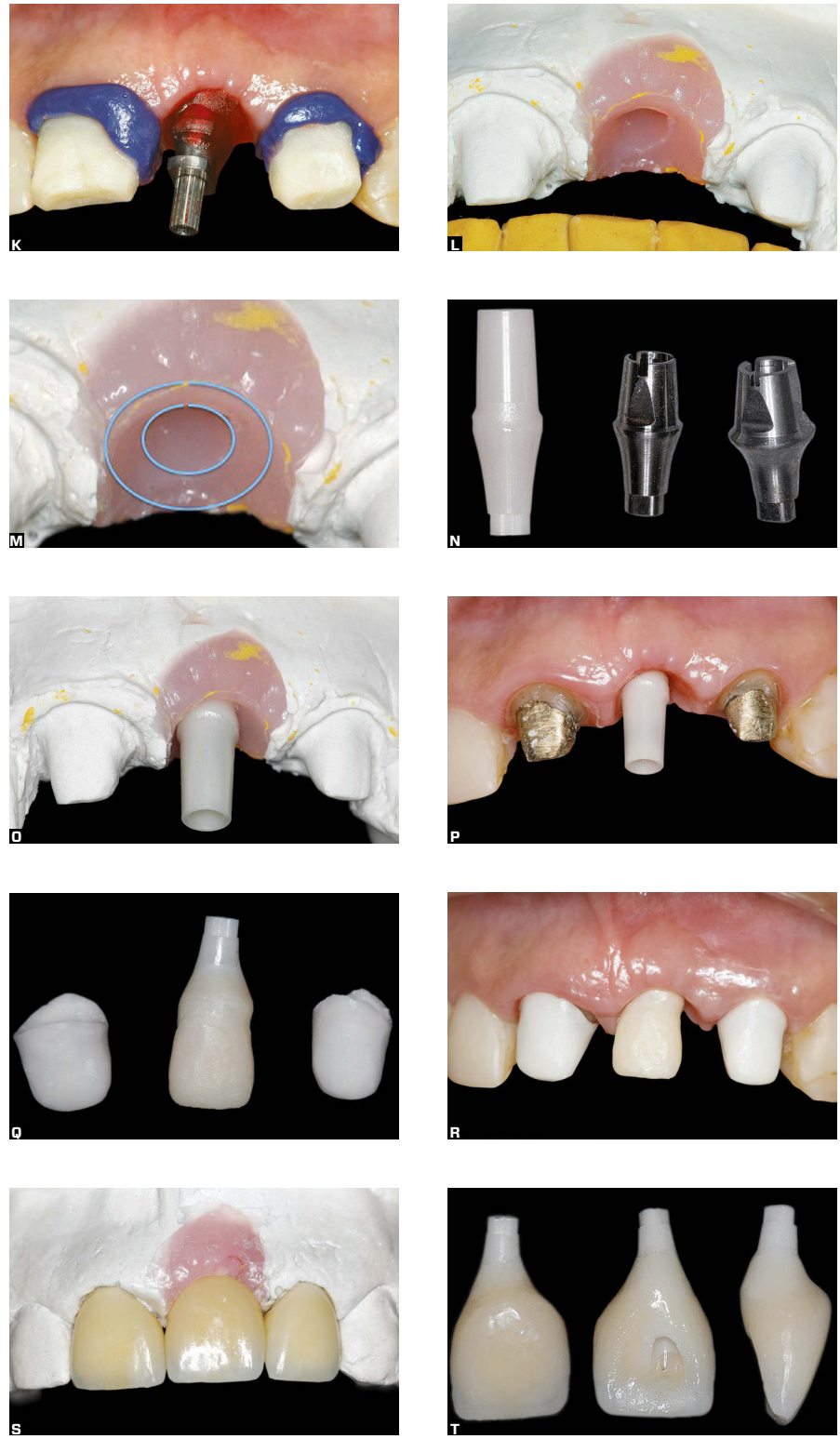

Figure 7 - **K**) Individual impression using resin tray and Impregnum (#11 and #22), and implant transfer using individual trays. **L**) Working model. **M**) Emergence profile and regular concave arch replicated in resilient artificial gingiva in cast. Notice the internal gingival contour shaped as a bell. **N**) Selection of definitive abutments with concave profiles. **O**) Zirconium abutment placed onto (screwed to) implant analog in cast, and try-in (**P**). **Q**) Zirconium components over preparation of teeth #11 and #22. Notice biological concave profile of prosthetic abutment. Beginning of application of ceramics over zirconium abutment. **R**) Try-in and clinical analysis of abutment and support components. **S**) Finished crowns positioned in working model. **T**) Proximal and buccal views show biological concave profile of prosthetic abutment.

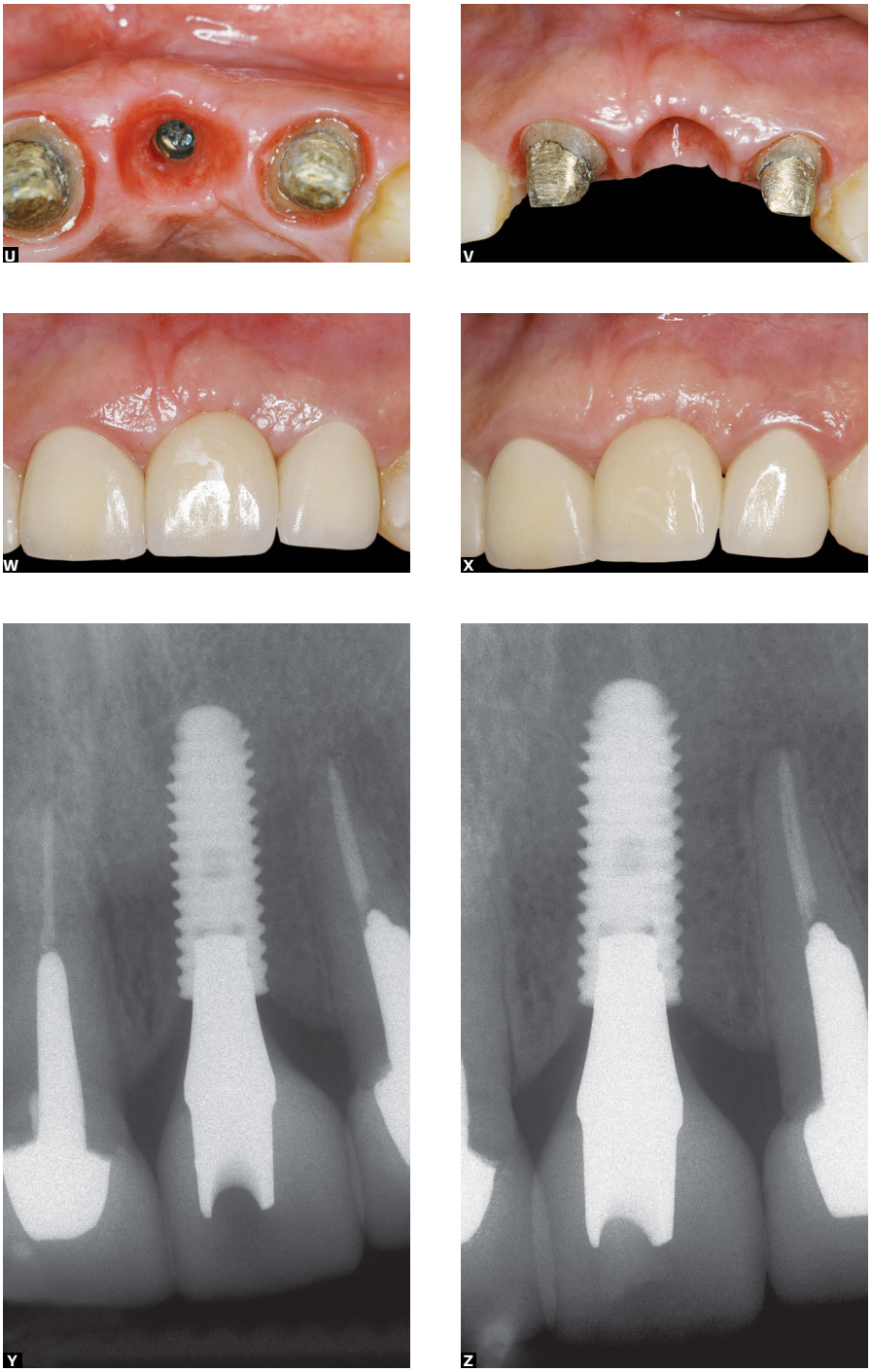

Figure 7 - **U**) Clinical aspect of gingiva at time of crown placement, showing space for prosthesis contour and emergence profile, and concave arch regular configuration (**V**). **W**) Placement of definitive crowns. **Y**) Immediate radiographic control. Notice biological concave profile of prosthetic abutment. **X**, **Z**) Clinical and radiographic 2 years follow-up. Notice gingival and bone stability.

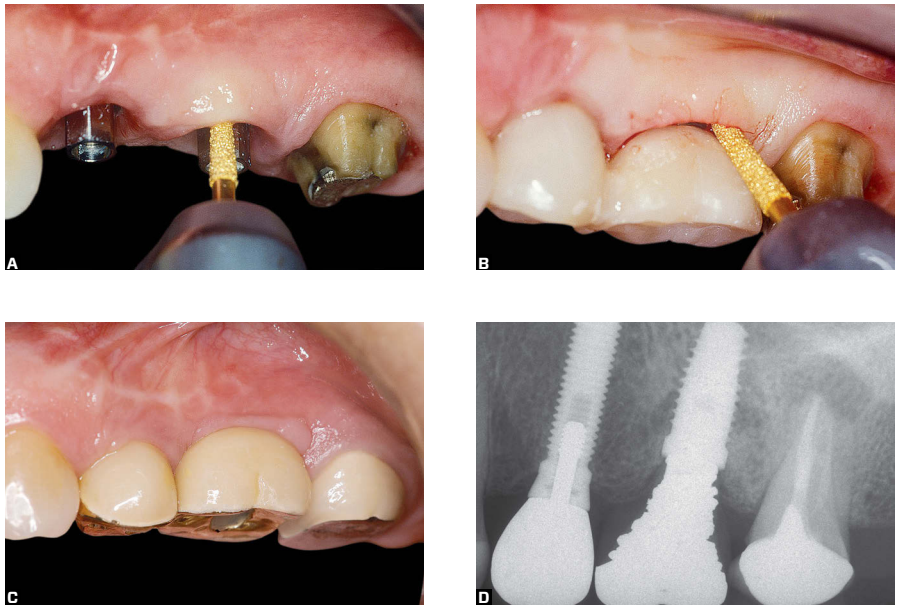

Figure 8 - **A**, **B**) Diamond-coated tip to reshape gingiva during surgery (IGC) before provisional crown placement. **C**) Crown placed over implant. **D**) Final radiograph shows peri-cervical bone progression.

Figure 9 - Bell: its external design is an example for abutment morphology.

After this intervention, the peri-implant site will be morphologically ready to receive a provisional prosthetic crown with the proper contour, including the biological concave profile of the prosthetic abutment and its coronal contour. The gingival contour of the provisional crown, as well as its biological concave profile, may be previously prepared in the cast. The final anatomy of the internal gingival contour should have the shape of a bell (Fig 9).

Important: the use of abutments with concave profiles (Fig 7N, 7T, 7U, 7V) should be an option whenever the objective is to optimize gingival esthetics. This type of abutment provides more room for the accommodation of cervical soft tissues, and precludes the need of an osteotomy for the placement of conventional abutments with a convex profile, which invariably compromise the preservation and stability of cervical peri-implant bone. Prosthetic abutments may have a slightly concave or concave profile, and their diameter should always be smaller

than that of the implant platform.[8] This distribution results in more space and, consequently, more gingival tissue, which results in greater stability, as well as protection and stability of the cervical peri-implant bone. For these reasons, they are called prosthetic abutments with a biological profile. The concave profile may be produced for any type of connection between prosthetic abutment and implant. This facilitates the use of internal connections, such as the Cone Morse connection, which increases the concavity of abutments and results in a greater amount of gingiva around the prosthetic abutment.

Bone stability and cervical peri-implant gingiva are much more closely related to the morphological and functional characteristics of prosthetic abutments than to the type of implant-to-prosthetic abutment connection.

Gingival recontouring, both in fresh and healed extraction sockets, is one of the most important steps in achieving satisfactory esthetic results. When we understand the importance of respecting the implant-crown-gingiva triad, the classical definition of esthetics as the harmony of all elements gains a profoundly more complex meaning.

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Subjective assessment of inferior alveolar nerve function after lateralization surgery

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Abstract

Introduction: Inferior alveolar nerve lateralization is an option to treat atrophic mandibles whose rehabilitation with prostheses may be limited due to vertical resorption in the posterior region and the short distance between the mandibular canal and the alveolar ridge. This surgery may result in paresthesia and sensory disturbances along the nerve path. **Objective:** To evaluate inferior alveolar nerve function and patient satisfaction after lateralization **Methods:** Twenty lateralization procedures were performed together with immediate placement of 52 implants. The same surgeon operated on all patients following a standardized surgical protocol. Six months after surgery, the patients answered a questionnaire about sensory changes after surgery and satisfaction with the results of the procedure. **Results:** All patients reported initial transient sensory disturbances and improvement at a mean 45 days after surgery, and some reported improvement after the third day. One had not recovered completely after 6 months. Despite sensory changes, all patients would undergo the procedure again if necessary and would recommend it to others. **Conclusions:** Inferior alveolar nerve lateralization seems to be safe and predictable, with minimal and reversible sensory changes and no significant damage to patients when performed according to a standardized surgical protocol.

Keywords: Mandibular nerve. Oral surgery. Dental implants.

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Introduction

The loss of posterior mandibular teeth leads to vertical bone resorption and limits the possibilities of surgical and prosthetic rehabilitation. In some cases, bone loss may be severe, and the placement of conventional implants is impossible. In such cases, rehabilitation options include the use of devices for osteogenic distraction, bone grafts, guided bone regeneration and the placement of implants lateral to the nerve, as well as inferior alveolar nerve lateralization (IANL) by moving the nerve laterally from its canal, or the inferior alveolar nerve transposition.[1-4]

After tooth loss, the alveolar ridge undergoes continuous and irreversible vertical bone resorption. This loss of bone height is assigned to the loss of teeth and the compression of the alveolar ridge due to the use of removable dentures. Therefore, bone resorption in the posterior mandible usually results in a shorter ridge, and, consequently, the placement of implants in this region becomes a challenge.[5]

Several surgical techniques have been developed for the rehabilitation of atrophic mandibles using osseointegrated implants.[6]

Onlay bone grafts require a second surgical site and result in a certain degree of resorption, risk of infection and two surgeries, which increases total treatment time.[3,6,7]

Bone quality in the posterior mandible is inferior when compared with the anterior region, and when short implants are chosen — so that the mandibular canal is spared —, initial implants' anchorage is monocortical and they are not very stable.[8]

The amount of bone above the mandibular canal is often insufficient for the placement of implants with a desirable length. Moreover, the bone above the mandibular canal has often lower quality than cortical bone. These factors, together with the higher rate of failure associated with short implants, led to the development of IANL techniques, which create the conditions for the placement of longer implants that reach the lower mandibular cortical bone and ensure greater initial stability.[9]

The current IANL technique has proven to be a good alternative to treat cases with vertical mandibular atrophy.[10] The nerve is exposed and carefully pulled out of the mandibular canal and moved laterally from its path so that the implants can be placed without disturbing the incisive nerve. This technique has stable results, and the implants can be fixed to the two cortical layers, which increases resistance to occlusal forces and ensures a good implant-to-prosthesis ratio.[11]

In the case of nerve transposition, the mental foramen is involved, and the incisive nerve is sectioned. Inferior alveolar nerve (IAN) transposition results in loss of sensation of its terminal incisive branch, which is insignificant in patients with no teeth in the anterior mandible, but may disturb dental and periodontal sensibility when the patient has anterior teeth.[12]

The greatest clinical difficulty associated with IANL is transient or permanent nerve dysfunction. All patients that undergo this surgery may experience neurosensory disturbances that often include paresthesia.[13]

IANL is a high risk surgery because it may result in reduced sensibility, paresthesia or total loss of sensibility in the region. Therefore, the surgeon that performs this procedure should master the operatory technique and be familiar with the anatomy of the region, as well as with the path of the mandibular canal and the physiology of the neurovascular bundle.[14]

Studies with objective and subjective tests have reported on the occurrence of sensory changes in a high percentage of cases, but most studies have been conducted with samples of patients from different surgeons, which makes it difficult to standardize the surgical technique because it is not possible to calibrate all surgeons for tissue manipulation.[14,15,16]

Thus, the present study subjectively evaluated IAN function after lateralization and simultaneous implant placement, besides the satisfaction of the patients that underwent this procedure.

Material and Methods

Twenty patients that underwent IANL evaluated their postoperative outcomes. Patients selected for the study were in good health, did not smoke and had no systemic diseases. They all had severe posterior mandible atrophy and chose to undergo rehabilitation using implants.

Inclusion criteria were: age greater than 18 years; IANL with immediate placement of osseointegrated implants; and follow-up until second-stage surgery for the placement of healing caps six months after IANL. Patients were operated on by the same surgeon following the same surgical protocol, from January 2010 to December 2011.

Exclusion criteria were: time from surgery shorter than six months; or abandoned the treatment.

Six months after IANL, the implants were re-exposed for impressions and prosthesis fabrication. At that time, the patients received a questionnaire about their satisfaction with surgery and were asked whether they would undergo surgery again, if necessary, and whether they would recommend this procedure to another person. No patient underwent neurosensory testing after surgery.

Before surgery, cone beam computed tomography scans were obtained to define IAN position.

Pre-operative oral medication was prescribed: 4 mg dexamethasone one hour before, and 15 mg midazolam for conscious sedation 15 minutes before the procedure.

Surgical technique

Regional inferior alveolar nerve block was combined with anesthesia of the buccal nerve and bundle in the buccal fornix using 4% articaine and adrenalin, as a vasoconstrictor agent, at 1:100,000 (72 mg + 18 µg/carpule).

As this surgery is always associated with implant placement, an incision was made along the entire thickness of the bone crest, extending posteriorly to the beginning of the ascending ramus and widely exposing the body of the mandible, and anteriorly to beyond the mental foramen, together with relaxing incisions in the canine and retromolar regions.

After total flap elevation and exposure of all the mandibular body and mental foramen, a tungsten bur was used to level the ridge crest. Later, the osteotomy area was outlined using a surgical marker to prepare the bone window. A #702 bur for straight hand piece was used for the superior horizontal and medullary osteotomy, followed by vertical distal, vertical mesial and inferior horizontal osteotomy (Fig 1). An osteotome was used to displace the bone block, and special attention was paid to avoid any injury to the neurovascular bundle. After that, the marrow was removed using a Molt periosteal elevator to detect the cortical layer along the entire mandibular canal. The osteotome was placed above and below the nerve, and the cortical layer was ruptured; immediately after that, the periosteal elevator was used to remove the cortical layer of the canal (through its vestibular surface, inferior and superior to the canal). With a hook-shaped handpiece, the nerve was release along its entire length and pulled

buccally with slight movements, and a piece of band was used to retract it delicately during the placement of the implants (Fig 2). After the implants were placed (Fig 3), the bone window was filled with crushed bone (the bone removed to form the window initially), filling the space between implants and the entire bone window space. Whether the amount of bone was not sufficient, Bio-Oss was used to complete buffering the fenestration. After the cavity was filled with bone, mono-nylon 5-0 was used for interrupted and continuous mattress sutures.

During postoperative follow-up, the patients were administered 875 mg amoxicillin every 12 hours for 7 days, 100 mg nimesulide every 12 hours for 3 days, 500 mg metamizole every 6 hours or 30 mg co-co-damol while pain persisted, and one tablet of 5,000 IU pyridoxine hydrochloride a day for 60 days. The patients received instructions not to wear their dentures during all the pre-rehabilitation time.

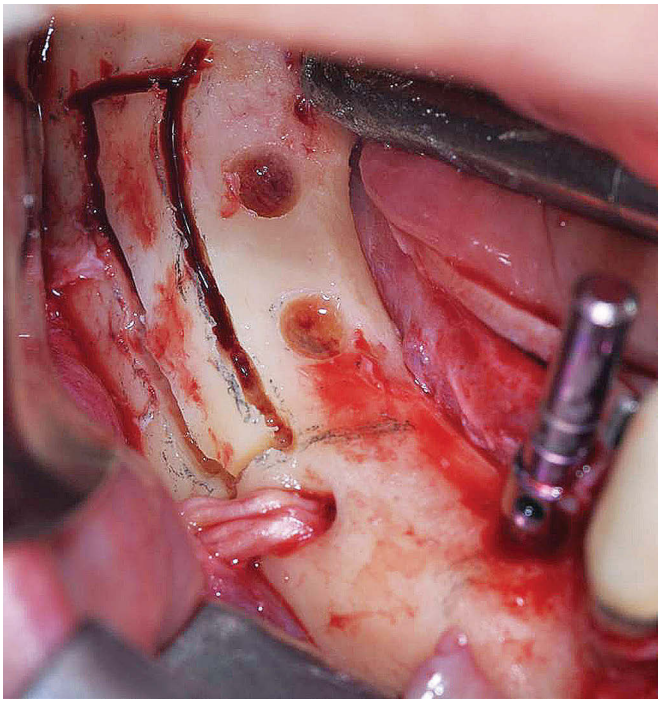

Figure 1 - Intraoperative photo taken after bone crest leveling, definition of implant position using round diamond point, and osteotomy of buccal wall.

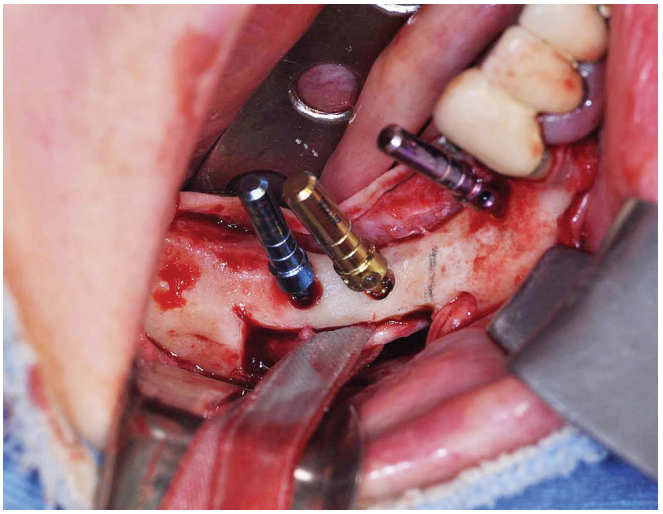

Figure 2 - Band retracting inferior alveolar nerve.

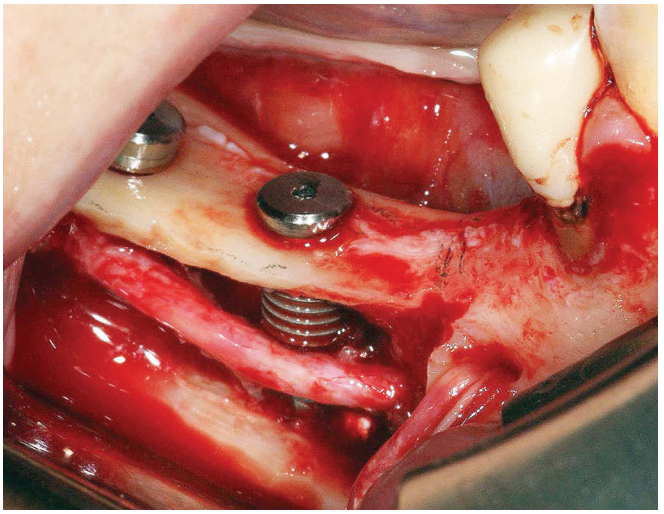

Figure 3 - After inferior alveolar nerve lateralization, implants delicately placed into bone cavity (not the same case as in Figures 1 and 2).

Evaluation method

A questionnaire was designed to register possible sensory changes and everyday life changes due to surgery, and the patient satisfaction after the procedure.

Implants were exposed 6 months after surgery. At that time, the questionnaire was handed to patients to measure postoperative sequelae. Data were analyzed using descriptive methods.

Results

Twenty men and women aged 42 to 75 years (mean age: 49 years) were included in the study, and 52 implants were immediately placed (Table 1). All patients reported initial sensory disturbances in the mental region as a result of surgery.

The shortest time to improvement was three days, and mean overall improvement was recorded at 45 days after surgery.

Of the 20 patients, only a 42-year-old woman reported still feeling neurosensory disturbances at the time the questionnaire was answered. She sometimes felt her lip, but not at other times. She also reported a gradual improvement of sensibility. Despite that, she would recommend the technique even if sensibility did not return to normal.

No patient reported interferences with daily activities or social life.

No patient reported irritability, accidentally biting their lips, pain or reduced salivation.

Table 1 - Sample of implants placed using the IANL technique.

Patients	Age	Placed implants	Implant failures
Case 1	48	3	0
Case 2	44	3	0
Case 3	47	3	0
Case 4	42	2	0
Case 5	60	3	0
Case 6	44	2	0
Case 7	43	2	1
Case 8	59	3	0
Case 9	45	3	0
Case 10	42	2	0
Case 11	75	3	0
Case 12	43	2	0
Case 13	47	3	0
Case 14	51	2	0
Case 15	55	3	2
Case 16	51	2	0
Case 17	46	2	0
Case 18	52	3	0
Case 19	47	3	0
Case 20	43	3	0

A total of 52 implants was placed, and osseointegration was not achieved in 3 of them, which were replaced without any new IANL.

All patients answered that they would undergo the procedure again, if necessary, and would recommend the treatment to others.

Discussion

Advances in dentistry have made the use of osseointegrated implant an established method to restore esthetics and function when patients lose teeth.

The posterior region of the mandible has the lowest success rates in Implantology, usually due to the unfavorable "implant-to-prosthesis" rate, monocortical implant anchorage and low bone quality.[2,5,8,9,13]

Despite the short evaluation time, the rate of success achieved in the present study was 94%, similar to the rate for conventional implants, and greater than the rate for implants in areas of onlay bone grafts.[17,18,19] This rate is very satisfactory taking into account the complexity of the cases treated.

The recommended alternatives for atrophic mandibles are: vertical bone grafts; guided bone regeneration; osteogenic distraction; horizontal osteotomy with interposition bone grafting; implant placement lateral to the nerve; and transposition or lateralization of inferior alveolar nerve.[1-4]

When other techniques are compared to IANL, their disadvantages are the need of a second operation for implant placement, the need of a graft donor site, the risk of resorption, the greater risk of dehiscence due to exposure and infection, and the need of a distance of at least 5 mm between the bone crest and the IAN.[3,11]

The surgical procedure described here involves transient or permanent neurosensory disturbances, experienced at different degrees by all the patients that undergo IANL,[1-7,11-16,20,21] as observed in our study. These disturbances are the result of direct IAN manipulation.

However, as demonstrated in the literature, as long as the patient is aware of the sequelae of this technique, dissatisfaction may be avoided.[1,4] Our study showed that, although there were sensory changes, all patients would undergo this surgery again, if necessary, or would recommend it to someone else. This indicates that the esthetic and functional benefits from this technique were more important than the sensory disturbances experienced. These disturbances seem to have a low impact on everyday life, as no patient reported changes in their daily activities after surgery.

IAN manipulation to place osseointegrated implants may be performed using two techniques: IANL, without involvement of the mental foramen, and IAN transposition, with mental foramen involvement. However, the lateralization technique has proven to be more conservative and result in fewer sequelae to the nervous bundle.[9,22]

This study did not use a membrane between the implant and the IAN. Studies in the literature do not show any consensus about the use of a barrier to protect the nerve and avoid sensory lesions.[7,22,23]

The IANL surgery may be performed in an outpatient environment with local anesthesia and conscious sedation.[3,14,22] However, this surgery also has indications of performance under general anesthesia.[3,20] Although some authors suggest the need of general anesthesia, implant placement is easier when the patient receives only local anesthesia.

When IANL is chosen, implants with more favorable length may be used in cases in which posterior mandible

resorption would force the use of shorter implants. Therefore, it provides longer longevity to rehabilitation.[3,6,24,25]

Although several treatments are available to improve IAN recovery, our patients did not undergo any treatment to accelerate neurosensory recovery besides the administration of 5,000 IU pyridoxine hydrochloride once a day for 60 days. Some authors have used laser therapy as an adjuvant therapy for neurosensory recovery, but no significant differences were found in time to neurosensory improvement when compared with our studies.[26,27]

Regardless of the technique used, the most important factor is the correct indication for each case, considering anatomy and site of defect, the patient's systemic health and, finally, costs and benefits to achieve esthetic and functional goals and restore patient quality of life.[7]

In this study, 95% of the patients recovered sensory functions in up to 6 months, which is in agreement with other findings in the literature.[1,2,4,5,7,11-16,20,21]

Conclusion

IANL is a useful technique for the rehabilitation of atrophic posterior mandibles in patients that still have their anterior teeth.

The risk of permanent mental nerve dysfunction seems to be small. Rehabilitation was achieved for all patients, without complications.

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The importance of keratinized mucosa and implant location on the bleeding on probing around osseointegrated dental implants

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Abstract

Objective: Our objective was to determine the association between the width of keratinized mucosa (KM) and implant location with the bleeding on probing (BOP) status of the soft tissue around osseointegrated implants. **Material and Methods:** A total of 172 patients, presenting 635 functioning dental implants was examined. The width of KM, the implant location and the associations of these analysis were divided into four groups. G1 - anterior area with KM ≥ 2 mm, G2 - anterior area with KM < 2 mm, G3 - posterior area with KM ≥ 2 mm and G4 - posterior area with KM<2 mm. **Results:** There was no statistical significance in any assessment ($p > 0.05$). **Conclusion:** The width of KM and the location of an implant have no influence on bleeding on probing around dental implants.

Keywords: Dental implants. Dental plaque. Periodontal index. Mucositis.

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Introduction

The presence of an adequate zone of keratinized mucosa was thought to be necessary for the maintenance of gingival health and prevention of periodontal disease progression. First, some authors suggested a width of at least 2 mm of keratinized mucosa, of which 1 mm should be attached gingiva.[1] Subsequently, several studies have challenged this concept and have shown that gingival health can be maintained with almost no attached gingival.[2,3]

The necessity of a zone of keratinized tissue adjacent to dental implants has been suggested.[4] It is especially important because the implant-supported restoration is located beneath the oral mucosa. Furthermore, the implant-mucosa interface differs from the interface between the mucosa and natural teeth, and these differences are important to the understanding of the susceptibility of implants to infection.

When using osseointegrated implants, supracrestal collagen fibers are oriented in a parallel rather than a perpendicular configuration. This creates a much weaker mechanical attachment compared to natural teeth.[5,6,7] In addition, it was suggested[8] that the ability of the peri-implant mucosa to regenerate itself is limited by its compromised number of cells and poor vascularity.

The sign of bleeding on probing (BOP) has been implicated as a valuable parameter in the diagnostic process for peri-implant mucositis, while probing depth has been adapted from periodontal diagnosis to assess soft tissue pathology and loss of bony support around osseointegrated oral implants.[9,10] Bleeding indicates the presence of an inflammatory cell infiltrate.[11,12]

Furthermore, gingival bleeding is related to the persistent presence of plaque on the teeth and regarded as a sign of the associated inflammatory response. Subjects who refrain from normal oral hygiene procedures have a resultant increase in plaque accumulation and demonstrate a concomitant increase in gingival bleeding as gingivitis develops over a 2-3 week period.[13] It has also been shown that the development of gingival inflammation and the associated bleeding are increased in smokers.[14]

It is evident that probing forces, dimensions of the probes and soft tissue conditions will influence their penetration depth.[15] In natural teeth, it has been established that the sign of BOP is related to the pressure applied on probing.[16] One recent study demonstrated that the maximum pressure to be applied to avoid false positive BOP readings around implants should not exceed 0.15 N. Hence, probing around implants demonstrated a higher sensitivity compared with probing around teeth.[17] It is also reported that at sites with healthy mucosa or mucositis, the tip of the probe may identify the location of the apical level of the epithelium barrier.[18]

Few studies have examined the relationship between the width of keratinized mucosa and the health of peri-implant tissues.[4,19,20] Moreover, the results of these studies are contradictory. Therefore, the purpose of the present investigation was to assess whether the location of the implant and the width of keratinized mucosa influence the bleeding on probing status around osseointegrated implants.

Material and Methods

This study was initially approved by the ethic committee for human research and all participants signed an informed consent (which was previously approved by the committee) before the onset of the study.

The subjects eligible for this retrospective clinical trial were identified from a population of 223 patients, which received dental implants from 08/03/2000 to 08/03/2010. All the smokers and the patients presenting *diabetes mellitus* were excluded from the study. A total number of 635 restored dental implants of 172 patients (with the mean

age of 50,56 ± 11,65 (21 to 86 years-old)) was randomly selected. This study comprised 60 males and 112 females patients. The implants were evaluated regarding the width of KM, the location of the implant and the association of these two features, making 4 groups (Table 1).

Clinical measurements were obtained through the use of a periodontal chart. Probing around dental implants was conducted in six sites (mesio-buccal, mid-buccal, distal-buccal, mesial-lingual, mid-lingual, distal-lingual) by means of a Teflon probe (PCV12PT Hu-Friedy Inc., Chicago, IL). Prior to the exam, the implant-retained prosthesis was removed for better visualization in areas with difficult access. After the exam, prophylaxis was conducted and the prosthesis was readapted.

The width of peri-implant keratinized mucosa (KM) was measured in millimeters on the midfacial aspect and classified as ≥2mm or < 2 mm. Differences in colour, texture and mobility between the keratinized mucosa and the lining mucosa served as markers for the detection of the mucogingival junction. The mucogingival junction was identified by the rolling technique, wherein the probe was rolled until the nonmovable portion of the attached keratinized tissue was seen. KM was then measured with a periodontal probe (PCV12PT Hu-Friedy Inc., Chicago, IL) as the distance between the gingival margin and the mucogingival junction.

Table 1 - Sample description: Number and proportion of implants related to location, width of keratinized mucosa (KM) and the associations of these features.

Clinical features	Dental implants (n = 635)	(%)
Width of KM		
KM ≥ 2 mm	228	35.91
KM < 2 mm	407	64.09
Implant location		
Anterior area	240	37.80
Posterior area	395	62.20
Groups		
1: Anterior area with KM ≥ 2 mm	135	21.26
2: Anterior area with KM < 2 mm	105	16.53
3: Posterior area with KM ≥ 2 mm	93	14.65
4: Posterior area with KM < 2 mm	302	47.56

Anatomic location of the implant was classified as anterior or posterior. Patient examination and collection of all data were performed using blind method, by an independent and experienced clinician who had been calibrated before the start of patient enrollment. Chi-square test was used for comparison among groups in order to verify which groups present statistical significance ($p < 0.05$). Statistical analysis was conducted by using the software Action 1.1.

Results

Regarding bleeding on probing (BOP), the implants were divided by area (anterior and posterior) to evaluate the influence of the anatomic location of the implant on BOP. It was found that the implants placed in the anterior area presented 31.67% (76 implants) of the sites with BOP; meanwhile, the same evaluation for the posterior area presented 25.82% (102 implants) with BOP ($p = 0.1340$).

Regarding presence of BOP related to the width of KM, the data obtained showed no statistical difference in the group containing the implants surrounded by ≥ 2 mm of KM. Also, this group presented higher percentage of BOP (31.14% - 76 implants) if compared with the group with < 2 mm of KM (26.29% - 107 implants) ($p = 0.2250$).

Evaluating the presence of BOP in association with implant location and width of KM the results were divided into four groups for better analysis. Subsequently, it was found that the implants placed in the anterior area with ≥ 2 mm of KM (Group 1) presented the highest percentage of BOP (32.59% - 44 implants), followed by Group 2 (30.48% - 32 implants), Group 3 (29.03% - 27 implants) and Group 4 (24.83% - 75 implants), respectively (Fig 1) ($p = 0.3505$).

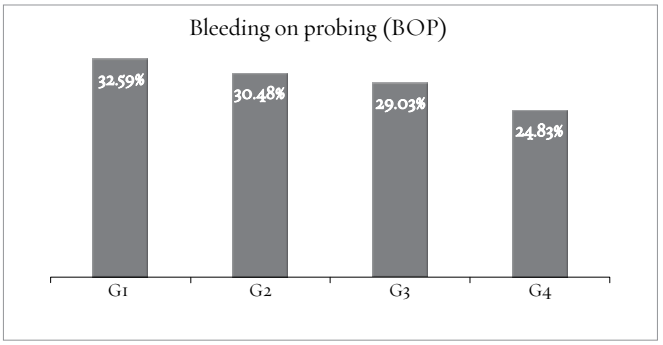

Figure 1 - BOP= bleeding on probing; G1=Anterior area with KM ≥ 2 mm (135); G2= Anterior area with KM < 2 mm (105); G3= Posterior area with KM ≥ 2 mm (93); G4= Posterior area with KM < 2 mm (302) (p = 0.3505).

Discussion

Evidence-based dentistry introduced studies and methodologies to improve the availability of information and new concepts. It allows us to choose a better treatment alternative to our patients. In the natural dentition, the keratinized mucosa includes the free and the attached gingiva and extends from the gingival margin to the mucogingival junction.[21] The question of whether or not the amount of keratinized gingiva around natural teeth has an impact on periodontal health and whether areas diagnosed as having little or no attached gingiva should consequently be treated accordingly has been a matter of controversy until today.[22]

An investigation confirmed that the lack of an adequate zone of attached gingiva did not result in an increased incidence of soft tissue recession in patients maintaining good oral hygiene.[23] In another study[24] was emphasized the importance of oral hygiene and demonstrated that minimal to zero attached gingiva could be maintained in a state of health, if adequate plaque control was provided.

In this context the results showed no statistical difference on bleeding sites of the implants located in the anterior area, compared with posterior implants.

There are varying opinions concerning the influence of a zone of keratinized attached mucosa surrounding dental implants. Several authors[21,25,26] reported that, in good oral hygiene conditions, the marginal gingiva around implants was clinically healthy, even when no keratinized mucosa was present. On the other hand, other investigators[5,27,28] reported a link between implant survival and width of keratinized gingival. The results of the present study show that the width of KM and the anatomic location where the implant was installed do not have any influence on BOP levels.

Despite the fact that studies suggest an association between the width of KM and the health maintenance of the peri-implant tissues,[29,30] the present study support the trend that even a deficient width of KM (< 2 mm) is enough for the maintenance of a healthy soft tissue around dental implants.[2,3,19,24] However this result should be interpreted with caution, especially in the anterior area, because the lack of an adequate zone of attached gingiva results in an increased incidence of marginal soft tissue recession.[27] For this reason we should bear in mind that this retrospective study only suggests explorative evidence; furthermore, it lacks data on the baseline KM width and thickness.

Conclusions

The width of KM or the implant position was not associated with bleeding on probing. Randomized controlled clinical trials are needed to confirm the results obtained in this retrospective clinical study.

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The use of short implant as a treatment option in a region of the maxilla with reduced bone height

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Abstract

Dental implants have been a safe option in oral rehabilitation. The short ones, under 10 mm, are used in clinical situations with great bone resorption after dental loss, instead of a bone grafting process. The present study consists in the case report of #15 tooth loss 17 years ago, and the subsequent deficit in residual bone volume. Among the possible treatment options with dental implants, it were presented to the patient: bone grafts and installation of conventional size implants; and the short implants. For being a more conservative option, with lower morbidity, lower cost and reduction of treatment period, the short implants became the patient's choice. Many papers have reported high index of success with short implants, considering the importance of bone quality, implant diameter, geometry, design, and surface treatment. This technique might be a good treatment alternative for areas where the volume bone is reduced. However the success of this type of treatment is related to the performing a judicious planning.

Keywords: Short implant. Bone graft. Osseointegration.

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Introduction

The use of dental implants has been considered as a safe and effective method for oral rehabilitation. This technique is currently responsible for improving the life quality of totally or partially toothless patients.

Implantology success is not related only to the maintenance of implants in the dental arch, but also to the concern about esthetics and a harmonic function, which is obtained by means of case planning, performance of surgical technique and installation of prosthesis.[1,2]

It is known that, from the osseointegration point of view, dental implants have high index of success,[3] however the use of this technique can be limited according to the presence of situations inherent to each patient, as for instance: the reduction of bone height or the presence of anatomical accidents.[4] The pattern of bone resorption in the posterior region of mandible and maxilla is asymmetric,[5] starting immediately after extraction of dental element, due to destruction of the canaliculi system — responsible for the innervation and blood nutrition — present between the alveolar bone and the preexisting periodontal ligament.[6] Besides, the absence of occlusal forces exerted on the alveolar ridge might lead to bone resorption.[7] The dental absence on the maxilla leads to horizontal bone loss in the buccal-palatal direction. And the deficit of vertical bone appears through natural remodeling in height caused by the pneumatization of the maxillary sinuses. In the mandible, this resorption occurs vertically resulting in little bone height and proximity to the mandibular canal, but with reasonable quantity on the horizontal plane. Therefore it becomes more complex the planning for rehabilitations on the posterior region of upper and lower atrophic dental arches.[8]

To overcome these physiologic and anatomic limitations, literature reports several techniques of bone grafting such as: *inlay/onlay* block grafts, osteogenic distraction, guided bone regeneration, maxillary sinus grafts and repositioning of the lower alveolar nerve.[9] However these procedures have little acceptance by the patients due to aspects related to necessity of multiple surgical procedures, greater post-surgical sensitivity, high costs and longer period of treatment.[4]

Short implants, i.e., under 10 mm of length,[10,11] made the rehabilitation on areas of ridges with great resorption, less complex, costly and traumatic to the patients.[12]

The present study aims to present a clinical case report in which a short implant was used in a maxilla with absence of bone height, as a way to avoid bone grafting complementary procedures.

Case report

Female patient, 57 years old, attended the dental clinic of UNIPAR, presenting an adhesive fixed partial prosthesis rehabilitating the absence of the tooth #15. During the anamnesis the patient reported that the tooth had been extracted 17 years ago and that the current prosthesis loosened often. In the clinical exam it was observed good presence of prosthetic space for rehabilitation (Fig 1). It was performed periapical (Fig 2) and panoramic radiographs, which indicated little residual bone height (5 mm of bone ridge), making it more complex the rehabilitation through osseointegrated implants with conventional size (over 10 mm). In this situation it were presented the following treatment options to the patient:

- Option 1 - Bone grafting and immediate installation of dental implant.
- Option 2 - Bone grafting and installation of dental implant posteriorly to period of bone repair.
- Option 3 - Installation of short implants.

After presented these treatment options, the patient chose the utilization of short implants, considering the lower cost, lower morbidity, reduction of a surgical step and reduction in treatment period.

The surgical step was initiated after the intra and extraoral antisepsis techniques and subperiosteal infiltration anesthesia in the buccal aspect of premolars region and with infiltrative complementation in the palatine. Posteriorly supracristal linear incision was performed using a 15c blade, in the region of the element #15, which was extended intrasulcularly towards the adjacent teeth — favoring the folding of a mucoperiosteal flap, with the aid of a Molt elevator. Then an osteotomy was performed respecting the sequence of drills for the previously selected implant. The installed implant was a cone morse Titamax WS with 4 mm of width and 5 mm of height with 45 N.cm fro locking. After positioning the cover screw it was sutured with nylon 5.0 and the adhesive fixed prosthesis was temporarily repositioned during the entire healing period. Orientations on post-surgical care were given to the patient, and medication to control the pain was prescribed (acetaminophen 750 mg every 8 hours for 3 days). The removal of the suture was performed 10 days after. After implant healing period, 5 months, it was performed a control periapical radiograph (Fig 3), reopening and installation of healer (Fig 4). After 20 days the unitary implant-supported prosthesis was installed, allowing the restoration of the patient's esthetics and masticatory function (Fig 5). After 18 months the patient returned for clinical and radiographic control exam (Fig 6).

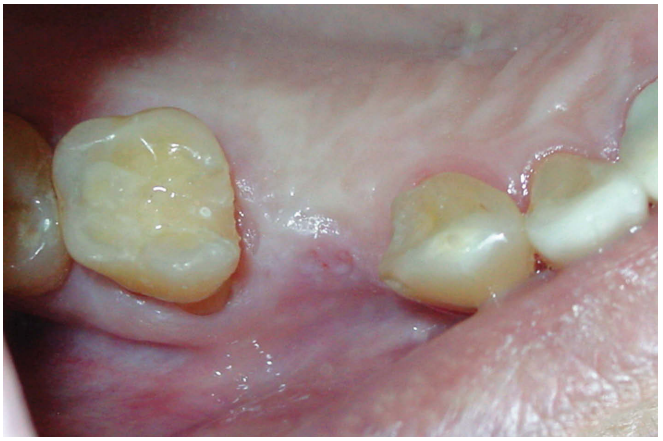

Figure 1 - Initial photograph of the receiving area.

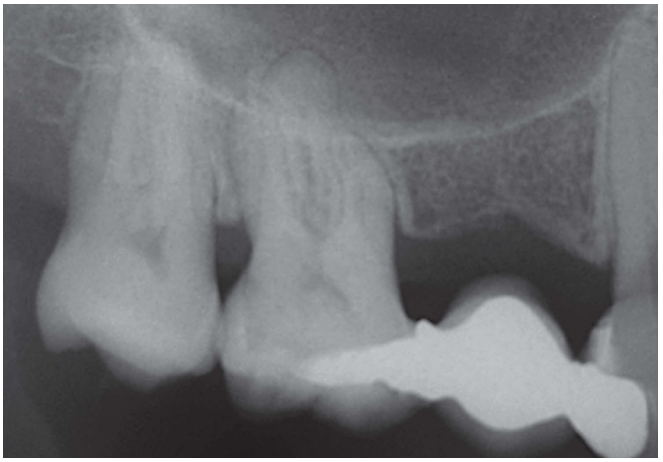

Figure 2 - Initial radiograph of the receiving area.

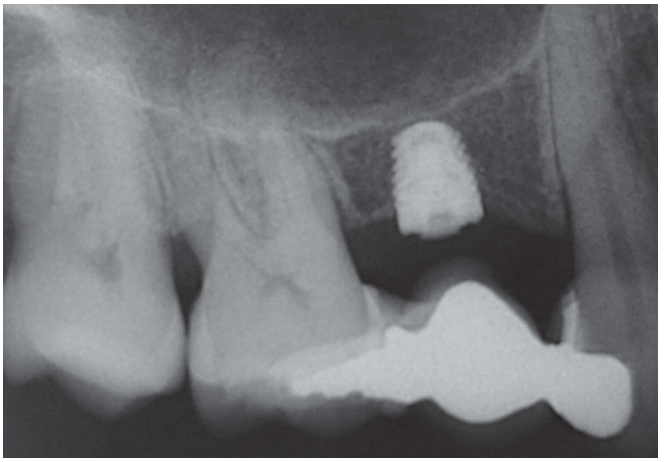

Figure 3 - Periapical radiograph 5 months after implant installation surgery.

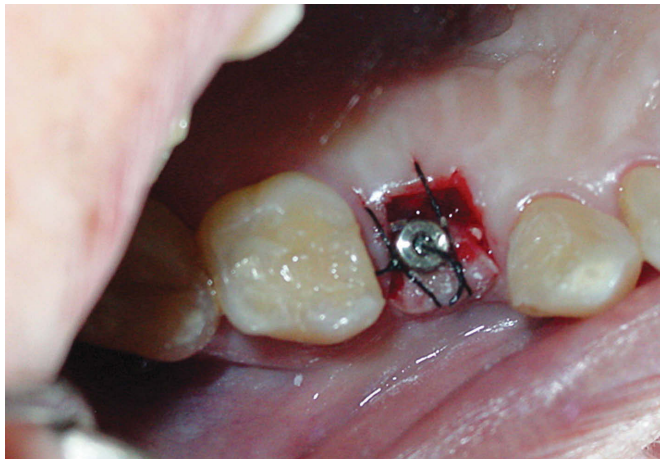

Figure 4 - Reopening and installation of the healer.

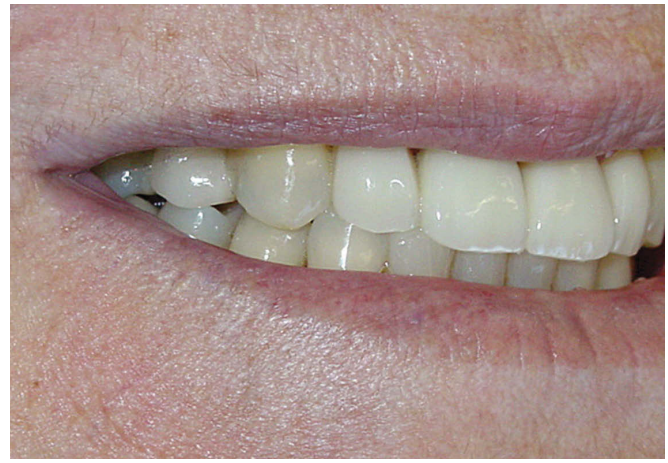

Figure 5 - Final photograph.

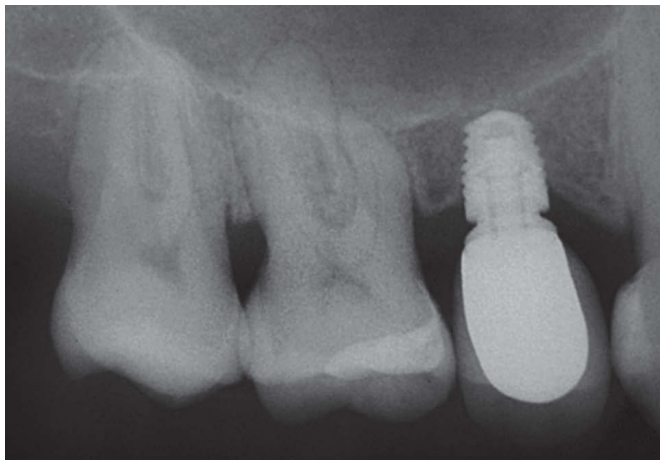

Figure 6 - Control periapical radiograph after 18 months.

Discussion

Today in Brazil there is a significative number of partial and total toothless individuals. With the increase in the life expectancy of the world population, it is common the presence of elderly with dental absences and necessity of prosthetic rehabilitation.[13,14]

With the extended use of conventional removable prosthesis, there is continuous resorption of bone tissue, providing greater discomfort and dissatisfaction to the patient.[15] Besides, it is known that bone tissue loss in areas limited by important anatomic structures — such as the mandibular canal and the maxillary sinus — might preclude the rehabilitation treatment with conventional osseointegrated implants.[4] With the advent of short implants a new possibility was developed for treating areas adjacent to these anatomic structures, avoiding grafting procedures and/or more complex surgical procedures.[16]

Nowadays it is difficult to find a consensus in literature, related to the term short implant, as regards to its length. Most authors consider short implants as the ones under 10 mm.[11,17,18] There are researchers who advocate as "short implant" the ones with 10 mm or less.[19,20] And there are those who believe that short implants must have length under 8 mm.[21]

Papers can be found reporting high index of success with short implants, however some aspects must be considered in order to improve this success: bone quality, implant diameter, geometry, design, surface treatment, number, position, crown-implant proportion, type of occlusion and forces magnitude.[10,22-26]

Bruggenkate et al[20] followed 253 treated surface implants, over a period of 1 to 7 years. Out of these, 45 located in the maxilla and 208 in the mandible, with 6.0 mm in length and 3.5 or 4.1 mm in diameter. Seven implants were lost: 5 in the maxilla because of inflammation in the healing phase and 2 (maxilla and mandible) due to bone loss without inflammation and with unitary crowns in molars. The remaining implants were followed over 6 years and resulted in a success rate of 94%.[20]

Another study reported the monitoring of 269 implants: 139 in the mandible and 130 in the maxilla in the sizes 6, 7, 8, 8.5 and 10 mm, in 111 patients, for 92 months. It was possible to observe that it were lost 12 implants: five of 7.0 mm, one of 8.0 mm, two of 8.5 mm, four of 10 mm. The success rate of 10-mm implants when compared to that of short implants did not present statistical significance.[27] According to the authors, the bone quality seemed to be a decisive and determinant factor for the success of short implants. The technological progress lead to an improvement on the surface of short implants, the success rate increased to values over 93%, very similar to conventional sizes implants.[22] Alterations on the shape and rugosity of the surface were developed to increase the mechanical imbrication between bone and implant improving the initial stability, resistance and dissipation of forces. Surface treatment accelerates the osseointegration process, allowing the premature installation of the prosthesis.[10]

In short implants the smaller length is compensated by the annexations of threads, substantially increasing the contact area between bone and implant. The region with greatest forces transmitted to the implant is near the bone crest, while the apical region receives less tension, therefore the length of the implant might not be the most important factor in the distribution of loading on the interface bone-implant.[10]

Although literature show some risk factors for short implants — such as high crown-implant proportion, greater occlusal loadings on the posterior region and little bone density in the premolars and molars regions[10,28,29] — it is important for the professional to develop a careful protocol that must be followed to control risk factors and optimize the results in order to compensate the smaller length of short implants. Implant design, surface treatment, splinting, absence of cantilever and canine guided occlusion are resources that improve results when using short implants.[10]

Conclusion

Short implants can be a good treatment alternative for specific cases in which there is absence of enough residual bone for installation of conventional implants. This type of implant can make the rehabilitation treatment less costly to the patients and less traumatic, for it can avoid complementary surgeries of bone grafting. However it is necessary that the professional specialist in Implantology perform a careful planning to minimize future problems.

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Surgical expansion of the alveolar ridge with immediate implant installation

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Abstract

Introduction: After tooth loss, the alveolar process undergoes gradual atrophy, making rehabilitation with dental implants impossible, in extreme cases. **Objective:** To report a clinical case of immediate implant placement in atrophic edentulous maxilla, after application of the alveolar ridge expansion (ARE) surgical technique in the anterior region and maxillary sinus floor lift (SL) in the posterior regions, along with autogenous bone graft removed from the ascending branch of the mandible. **Conclusion:** ARE and SL are viable, safe and predictable alternatives for increasing the thickness and height of the alveolar ridge with rehabilitation purposes.

Keywords: Alveolar ridge expansion. Maxillary sinus. Dental implants.

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Introduction

For a successful dental implant rehabilitative therapy, the presence of bone in a suitable quantity and quality is mandatory.[1] As result, atrophic alveolar ridges in edentulous maxilla are borderline to the prosthetic rehabilitation with implants.[2]

Edentulous areas in the posterior maxilla present an insufficient bone quantity due to the pneumatization of the maxillary sinus and bone crest resorption after tooth loss, especially in the vertical direction. In the anterior region, the resorption is predominantly caused by labial pressure, consequently, the loss is more significant in the horizontal direction.[3]

Aiming at the restoration of an appropriate surgical site and implant placement, procedures as guided bone regeneration, alveolar osteogenesis distraction, using alloplastic materials and bone grafts to achieve bone height and thickness, are used.[4]

In 1970, Tatum[5] first presented the technique for lifting the maxillary sinus floor, named as sinus lift (SL). However, Boyne and James,[6] in 1980, were the first to report a case in which they described the technique to elevate the maxillary sinus for placing autogenous grafts in order to achieve bone height and thickness, allowing the installation of dental implants.

In 1992, Simion et al[15] described the surgical technique for alveolar ridge expansion (ARE), to increase bone thickness and allow the implant placement in atrophic ridges. The technique consists in conducting a longitudinal greenstick fracture on the atrophic ridge, by making a horizontal osteotomy in the bone crest and two vertical osteotomies, attached to the first one, in mesial and distal ends.

Its indication is restricted to alveolar ridges presenting cancellous bone between the buccal and lingual/palatal walls, base larger than the bone crest, at least 3 mm thick and 10 mm high. As main advantages are cited the low cost, the possibility of immediate implant placement and shorter treatment time.[8,9,10]

The aim of this paper is to describe the immediate implant placement in an atrophic edentulous maxilla after performance of alveolar ridge expansion surgical technique and sinus lifting in combination with autogenous bone graft removed from the ascending branch of the mandible.

Case report

A 72-year-old male, leucoderma patient sought the Dental School of Piracicaba, State University of Campinas (FOP-UNICAMP), complaining about the instability of upper and lower dentures, and showing interest in rehabilitation with upper and lower fixed prostheses.

Physical examination showed moderate atrophy of the alveolar ridge crest (Fig 1) and radiographically, it was observed bilateral pneumatization of the maxillary sinus in the posterior region and less than 5 mm height from residual ridge, unlike the anterior region, with 10 mm (Fig 2).

The treatment plan was the rehabilitation of mandible and maxilla using 5 and 6 implants, respectively, under local anesthesia, for subsequent installation of fixed prostheses. It was performed the technique of bilateral sinus lifting in the posterior region and surgical expansion of the alveolar ridge in the anterior region.

A longitudinal incision was performed under the alveolar crest, with mesiodistal limits beyond the osteotomy area, bilaterally onto the first molar region, and two relaxing vestibular incisions. A full-thickness flap was lifted on the buccal aspect, preserving the vascularity of the palatal bone segment (Fig 3).

In the posterior region, maxillary sinus was accessed by the lateral wall of the maxilla with the aid of a spherical carbide drill at low speed and the membrane was lifted with non-cutting curettes (Figs 4 and 5). Horizontal osteotomy was performed using a #700 drill in the atrophic alveolar ridge, to break the cortical bone and to reach cancellous bone (Fig 6). Expansion of the buccal wall was obtained by using straight chisels to a height of 6 mm (Fig 7). Surgical sites were then prepared for placement of four 11-mm long implants in the anterior region and two 9-mm long implants in the posterior region (Fig 8), obtaining primary stability for all of them. Then, the bone graft from the ascending ramus of the mandible was used to fill the windows obtained by sinus lifting and spaces between the implants (Figs 9 and 10). Finally, the flap was positioned and sutured in such a way to completely cover the bone and implants. In a second procedure, it was performed the installation of five implants in the anterior mandible. It can be observed in the postoperative radiographs (Fig 11) an adequate sinusal bone gain and proper positioning of the implants.

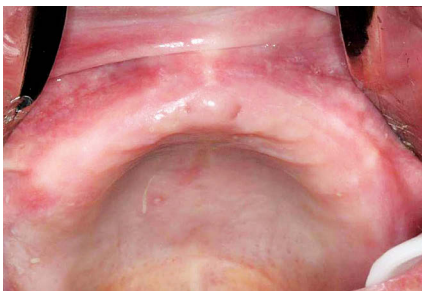

Figure 1 - Atrophy of the alveolar ridge.

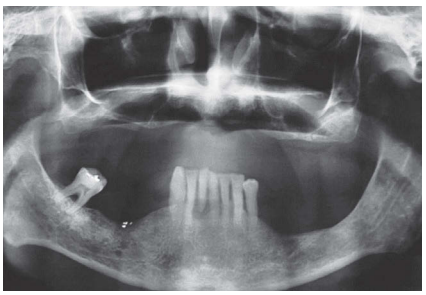

Figure 2 - Pneumatization of the maxillary sinus and sufficient bone height.

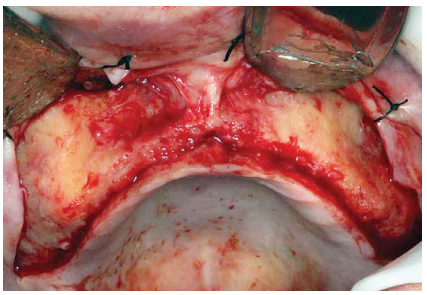

Figure 3 - Detachment of the mucoperiosteal flap.

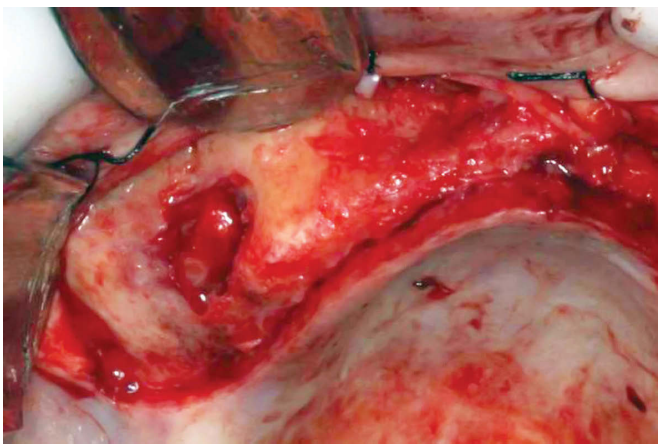

Figure 4 - Right maxillary sinus lift.

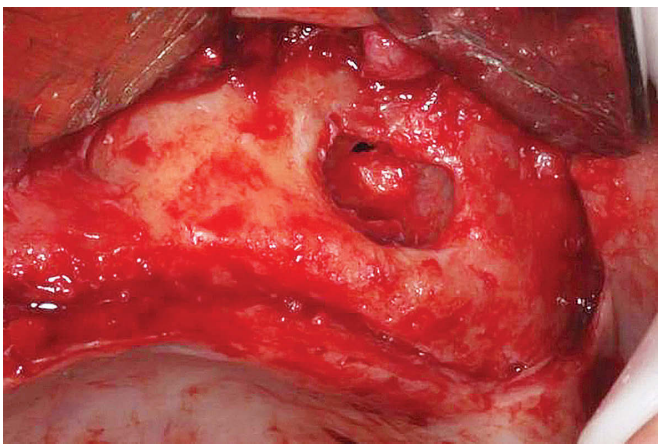

Figure 5 - Left maxillary sinus lift.

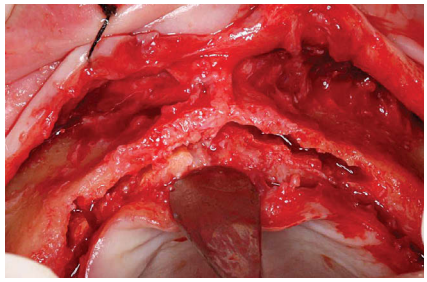

Figure 6 - Osteotomy in the alveolar ridge crest.

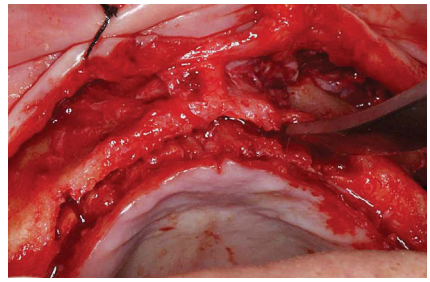

Figure 7 - Alveolar expansion with the aid of chisels.

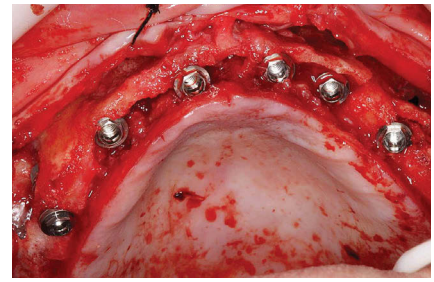

Figure 8 - Installation of 6 implants in the maxilla.

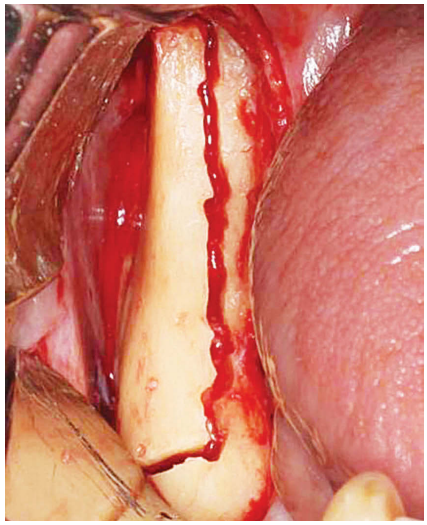

Figure 9 - Donor area.

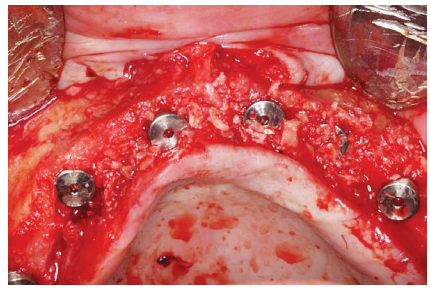

Figure 10 - Filling the maxillary sinuses and the spaces between implants.

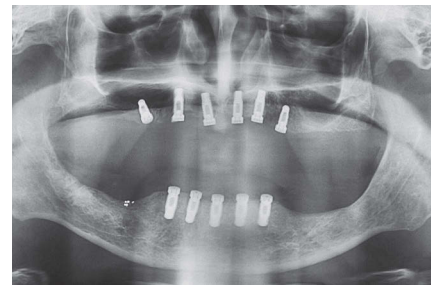

Figure 11 - Appearance of implants placed in the maxilla and mandible.

Discussion

The risk of sinus membrane perforation during the procedure of lifting the maxillary sinus is smaller in atraumatic technique. However, the choice between one or the other is based on sub-sinusal bone density and height required for placement of dental implants. To perform the atraumatic technique it is required a sub-sinusal bone length of 5 to 6 mm for a bone gain of 3.5 to 5 mm to be obtained, whereas for the traumatic technique it is required 2 to 5 mm of bone[11] for an elevation of 10 to 12 mm. In the present case, the height of the bone in the posterior alveolar crest was about 2 to 3 mm, reason why traumatic technique was chosen.

In the literature, the surgical technique described for carrying out the ARE is a longitudinal greenstick fracture of the vestibular bone wall, in which two parallel osteotomies in vestibular bone wall are joined by another osteotomy in the bone crest.[8,12] In this case reported, it was performed only the longitudinal osteotomy, also described by other authors.[10,13] This fact is justified by the predominance of type III bone in the anterior maxilla, which exerted little mechanical resistance during the expansion process, thus complementary osteotomies were not required.

This technique is limited to ridges which present bone marrow between the buccal and lingual/palatal walls and have a base larger than the bone crest, thus being restricting for cases of patients with atrophic ridges where it is intended to gain bone only in horizontal axis.[8,10,13] However, another viable option for subsequent rehabilitation with implants would be bone grafting for reconstruction of the entire maxilla. The iliac crest is the most used extraoral site for extensive reconstructions, and has the disadvantage of requiring hospitalization, general anesthesia, presenting high morbidity, higher costs and cutaneous scar formation.[14]

It was observed that with the use of these two techniques simultaneously to bone grafting, immediate installation of implants was possible, significantly reducing the treatment time and amount of bone needed for reconstruction.

It must be observed the importance of proper planning, bringing greater predictability when the ARE and SL are indicated.

Conclusions

In the case presented, the ARE provided satisfactory horizontal gain that allowed the placement of dental implants.

The surgical procedure should be carried out within biological limits, using suitable instruments in order to avoid an undesirable fracture during expansion and/or rupture of the sinus membrane.

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Comparative finite element analysis of stress distribution in pilars of fixed dentures supported with tilted versus nontilted posterior implants

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Abstract

Introduction: According to the all-on-four treatment concept, tilted posterior implants reduce distal cantilever length. **Objective:** By means of three-dimensional finite element analysis, to elucidate the biomechanics of these devices and evaluate the use of tilted versus nontilted posterior implants and angled abutments in the treatment of the edentulous jaws. **Methods:** Four three-dimensional mandible models were created to simulate cortical and cancellous bone. The models received four parallel implants with straight abutments, or two vertical implants and two posterior implants titled at 17 or 30 degrees with straight or angled abutments. All models received axial loading or off-axis loading on one or both sides of the prosthesis. **Results:** The greatest stress concentrations were found for vertical implants and angled abutments. Tilted posterior implants favored stress distribution. **Conclusion:** The all-on-four treatment concept and the use of straight abutments favored the biomechanics of implant-supported full dentures.

Keywords: Vertical implants. Tilted implants. Finite element analysis.

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Introduction

The rehabilitation of atrophic mandibles is a challenge for oral rehabilitation specialists. Patients with edentulous mandibles have poorer mastication and undergo facial changes, a reduction of the lower third of the face, chin projection, deterioration of self-esteem, and limitations to their social life. Rehabilitation of this clinical condition usually consists of conventional removable complete dentures, implant-retained prosthesis and overdentures, or implant-supported fixed complete dentures, which ensures efficient mastication and has the highest level of patient acceptance.[23]

However, implants cannot be placed in the posterior region of atrophic edentulous jaws because of insufficient bone height and the presence of important anatomic landmarks, such as the mandibular canal. Therefore, fixed complete dentures with long posterior cantilevers, an unfavorable biomechanical condition, have to be used.[11]

Tilted implants, an adaptation of the conventional technique, have been used to obtain better anchorage of longer implants, simplify surgery—as grafts are not required—and improve biomechanics as the distal cantilever may be shorter in implant-supported fixed complete dentures.[6]

The biomechanics of clinical rehabilitations with fixed dentures using tilted implants must be clearly understood for treatment success and longevity. Although osseointegrated implants have a high success rate, the results of studies regarding the biomechanical behavior of tilted implants are inconclusive.[18] The present study compared the distribution of stress during treatment using a mandibular implant-supported fixed complete denture, tilted osseointegrated implants, and angled and straight abutments.

Material and Methods

Models of a mandibular full denture and of a resin mandible (Nacional Ossos, Jaú, Brazil) were scanned with a three-dimensional (3D) laser scanner (Nextengine HD, Santa Monica, CA) to produce virtual 3D models. Sixteen circular scannings at 22.5-degree intervals were made for the prosthesis model and 16 for the mandible model. After virtual reconstruction, the 3D models were exported to a CAD tool (Solidworks 2010, Dassault Systemes, Solidworks Corp, Waltham, MA) for the edition of the virtual models. To define the cortical and cancellous bone, peel mill was used to a 2-mm thickness: the external portion was cortical bone, and the internal, cancellous bone. As there is no standard bone thickness, this measure was used to represent a type III bone, which is thin cortical bone according to the classification by Lekholm and Zarb.[17]

For standardization, all implants and abutments were based on SIN products (Sistemas de Implantes, São Paulo, Brazil). When the virtual models were ready, four groups were created according to the following study factors: posterior implants were vertical or tilted, and abutments were straight or angled, according to the following models (Fig 1).

Model 1. Four parallel vertical implants and straight abutments perpendicular to the bone crest, distributed in the anterior mandible, with the two posterior implants placed 3 mm anterior to the mental foramen.

Model 2. Similar to model 1, but posterior implants were tilted to 17 degrees, and abutments were straight.

Model 3. Similar to model 1, but posterior implants were tilted to 17 degrees, and abutments were angled.

Model 4. Similar to model 2, but posterior implants were tilted to 30 degrees, and abutments were straight. Three loading parameters were used in each model — First parameter = occlusal loading of all artificial teeth along the axis of anterior implants (60 N for molars, 40 N for premolars and 20 N for anterior teeth); Second = 135 N at three different points on the same side, one on each posterior tooth, along the axis of anterior implants; Third = same load as for the second parameter, but applied at a 45-degree lingual inclination to the long axis of anterior teeth (Fig 2).

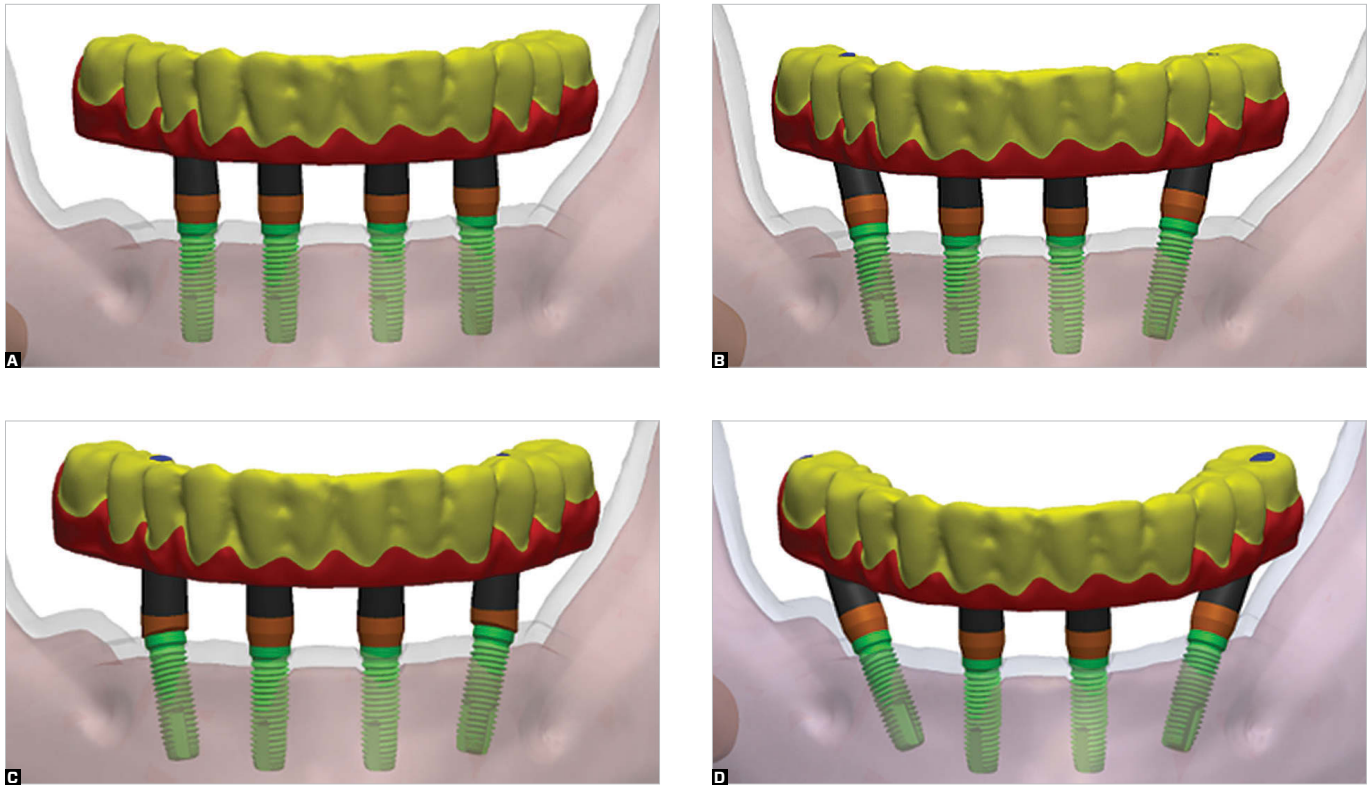

Figure 1 - Different study models; bone is semitransparent for better visualization of implant position: **A**) model 1; **B**) model 2; **C**) model 3; **D**) model 4.

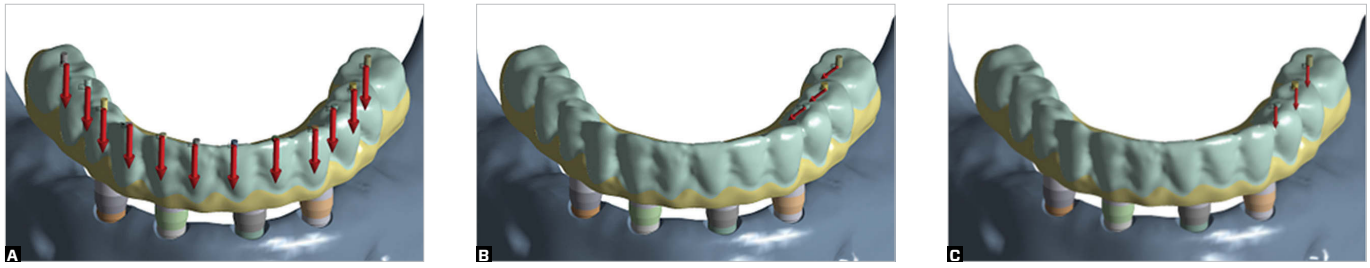

Figure 2 - Loads applied: **A**) axial load on all teeth; **B**) posterior axial load on one side; **C**) posterior off-axis load on one side.

The response criterion was maximum principal stress on metal framework using the Rankine criterion and von Mises stress in bone.

Results

The results of maximum principal stress on the metal framework using Rankine criterion are shown in Table 1. For metal frameworks, posterior implants tilted to 17 degrees had better stress distribution, and stress concentration was higher in the cases of vertical implant placement.

Figures 3, 4 and 5 show maximum principal stress distribution for the three patterns of occlusal loading.

Table 1 - Maximum principal stress peaks on prosthesis framework that received three different loads (in MPa).

	Model 1	Model 2	Model 3	Model 4
Axial load on all teeth	114.15	62.54	68.42	65.43
Posterior axial load on one side	126.26	66.88	71.66	31.73
Posterior off-axis load on one side	146.93	129.18	126.69	91.70

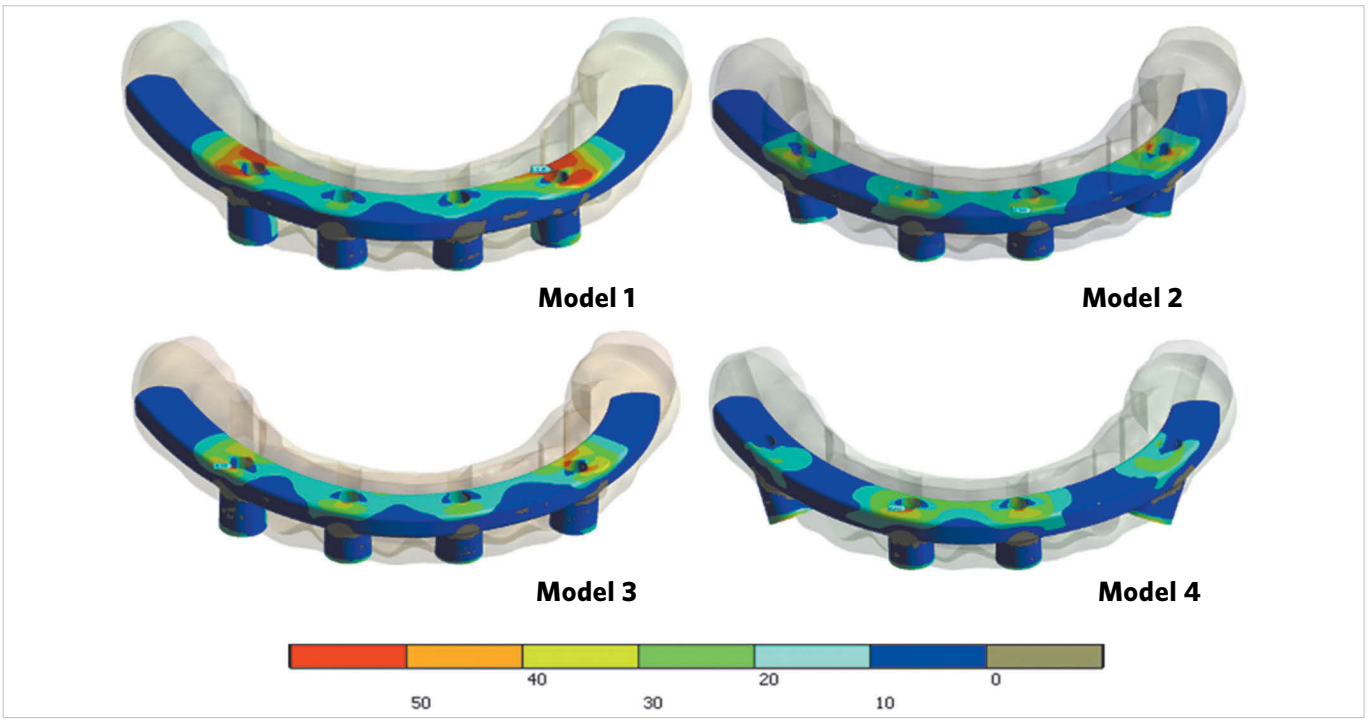

Figure 3 - Maximum principal stress on framework in models 1, 2, 3 and 4 that received axial loads on all teeth. Scale applies to all plots in figure.

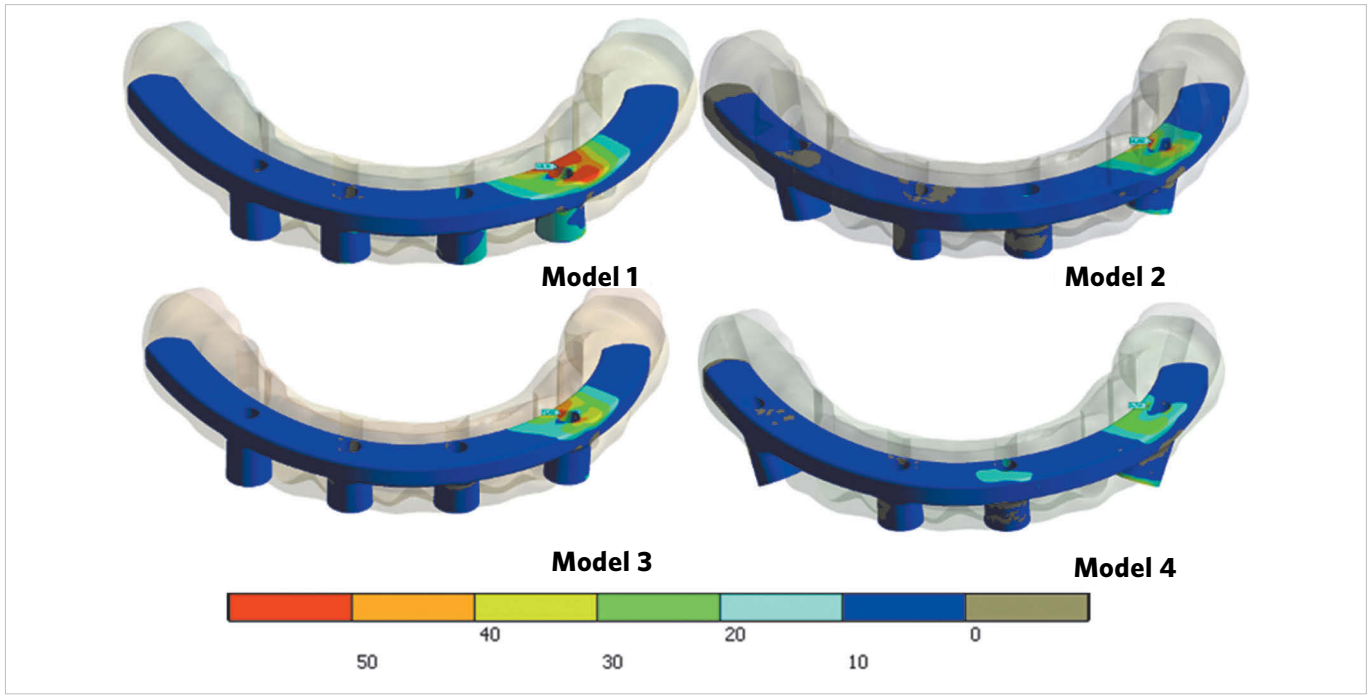

Figure 4 - Maximum principal stress for models 1, 2, 3 and 4 that received posterior axial load on one side. Scale applies to all plots in figure.

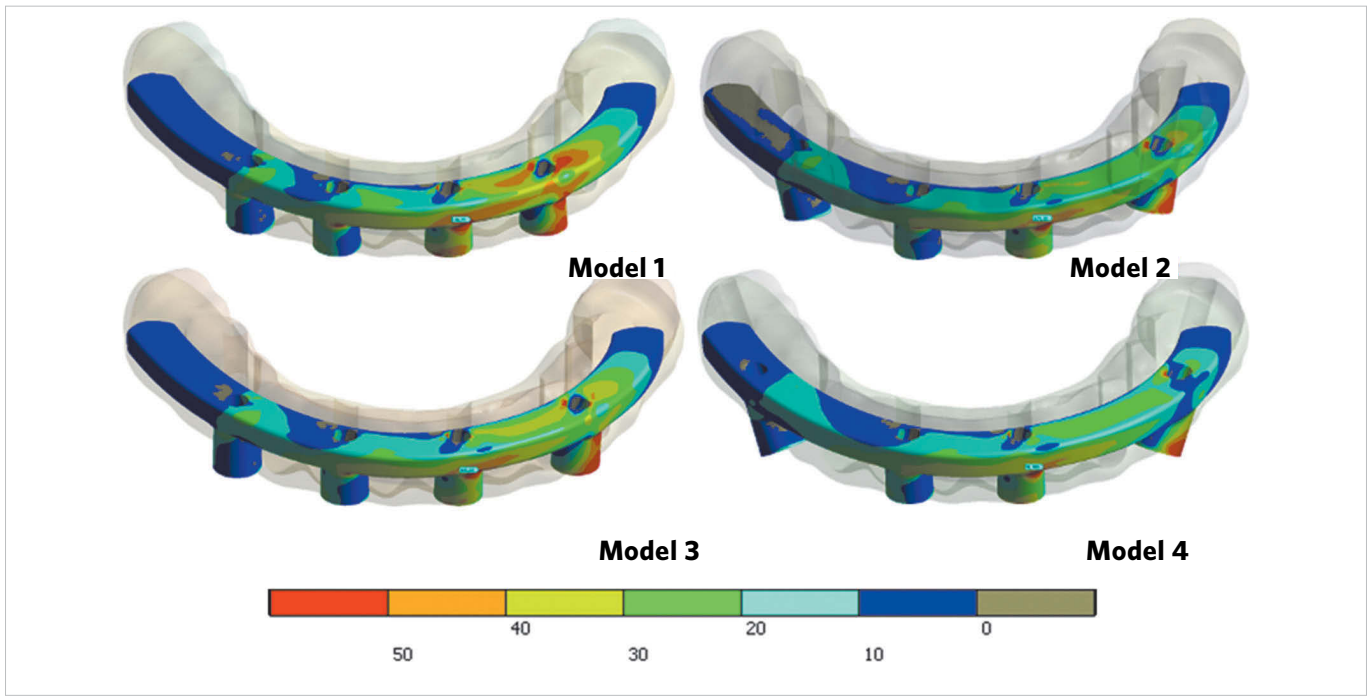

Figure 5 - Maximum principal stress for models 1, 2, 3 and 4 that received posterior off-axis loads on one side. Scale applies to all plots in figure.

Stress distribution on bone in the four models and the three occlusal loading patterns was similar, and stress concentration was higher around the posterior implants than the central implants (Table 2). The evaluation of the posterior implant angles revealed that the 30-degree angle led to a higher concentration of stress on mandibular bone. However, the use of angled abutments did not affect the level of stress on bone around the implants. Figures 6, 7 and 8 show von Mises stress distribution on bone for the three patterns of occlusal loading.

Table 2 - Stress peaks (in MPa) according to von Mises criterion for different models under axial load on all teeth (I); posterior axial load on one side (II); and posterior off-axis load on one side (III).

Implant	Model 1			Model 2			Model 3			Model 4		
	I	II	III	I	II	III	I	II	III	I	II	III
Posterior right side	38.98	4.15	31.2	42.02	6.00	32.31	41.55	6.04	31.16	43.80	6.37	32.68
Anterior right side	17.34	7.79	25.99	24.04	5.06	26.93	20.77	4.24	5.67	25.01	5.67	27.86
Anterior left side	17.95	10.59	30.78	24.47	14.77	28.31	22.51	10.86	26.99	27.84	17.92	28.25
Posterior left side	37.50	37.84	80.81	40.24	41.98	86.88	39.98	40.06	84.95	44.97	45.14	88.87

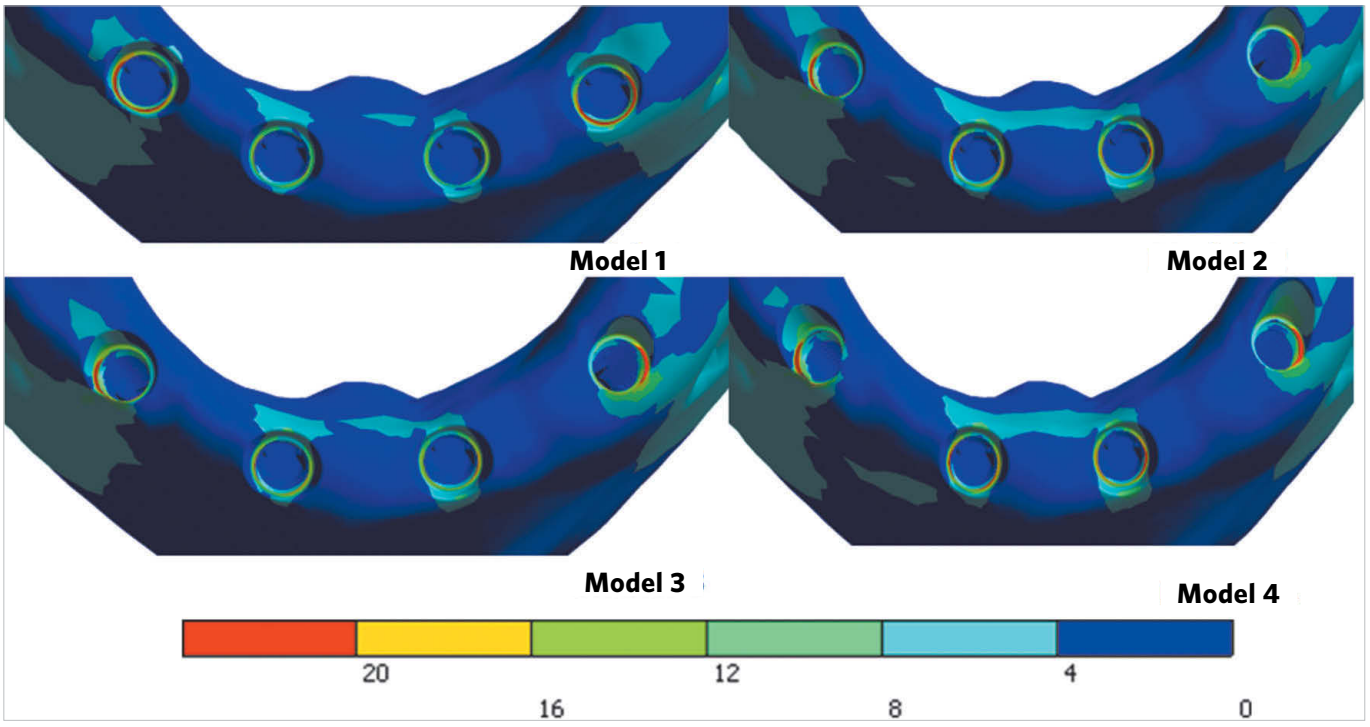

Figure 6 - Von Mises stress for models under axial loading on all teeth; occlusal view. Scale applies to all plots in figure.

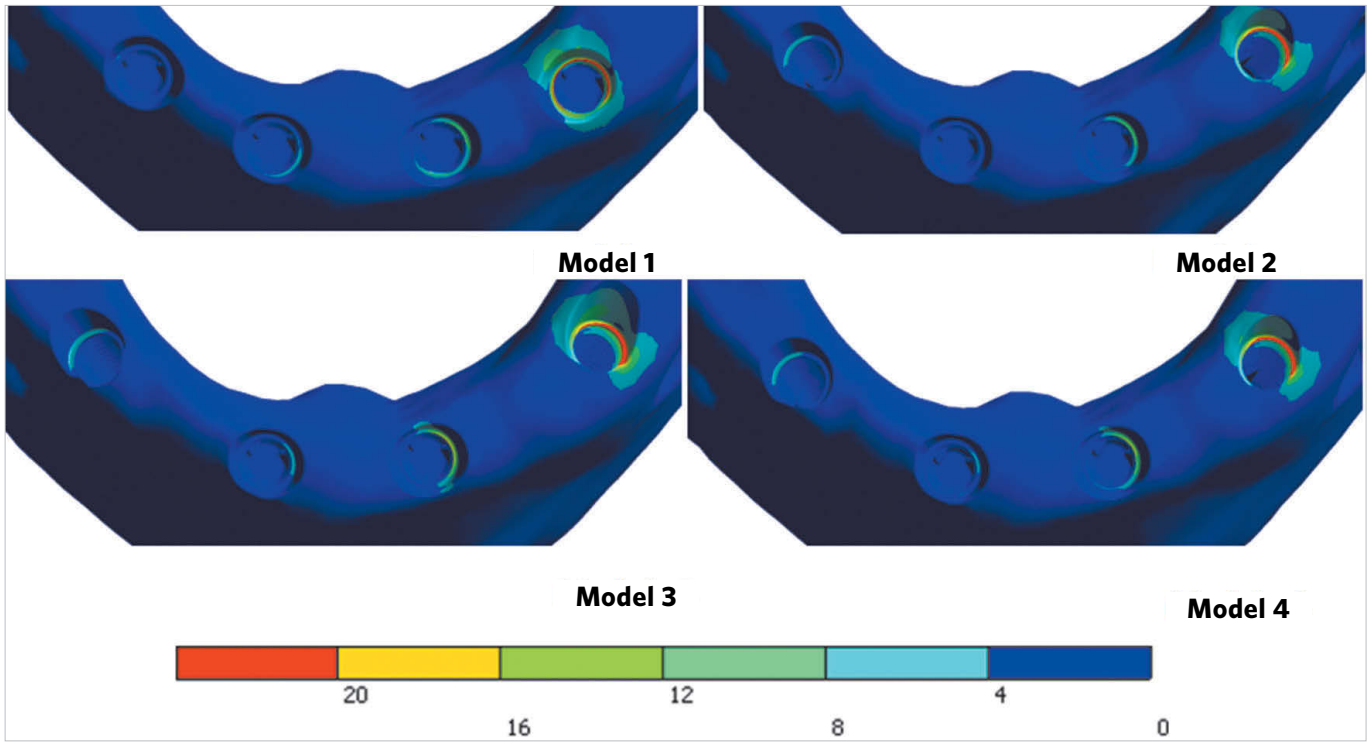

Figure 7 - Von Mises stress for models under posterior axial loading on one side; occlusal view. Scale applies to all plots in figure.

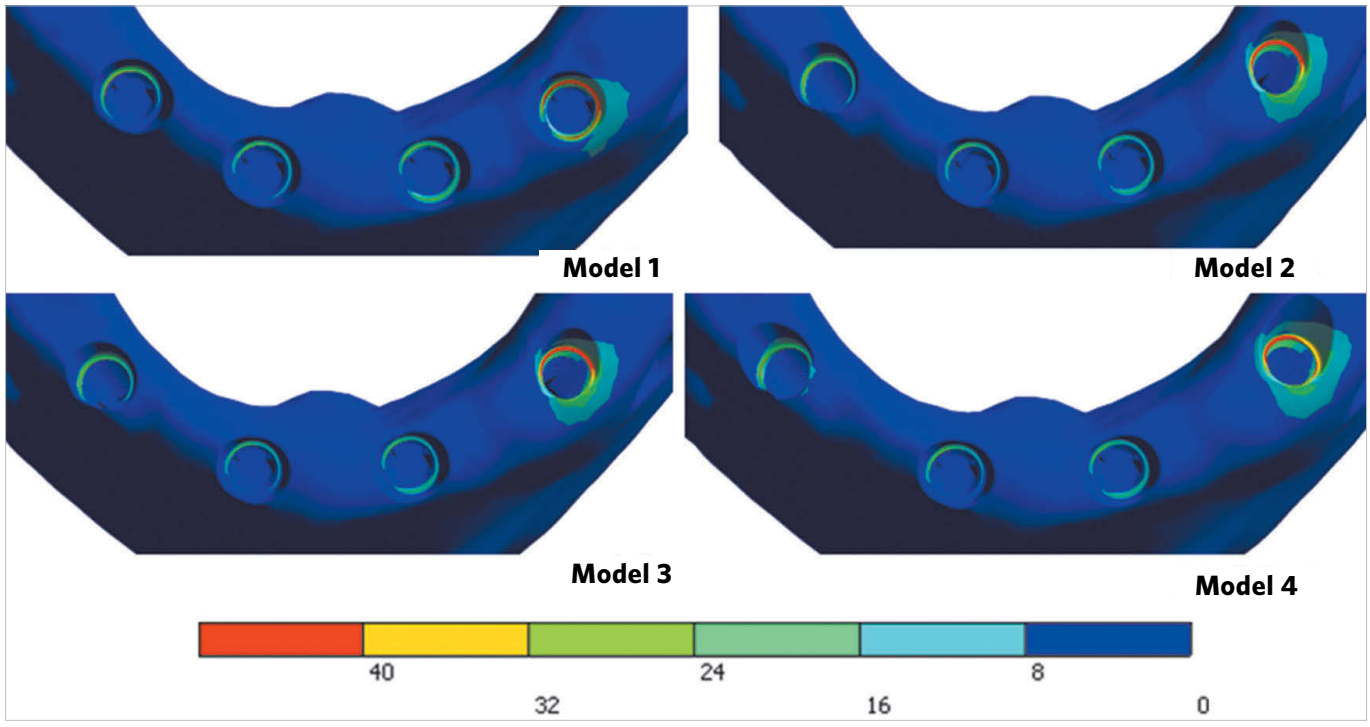

Figure 8 - Von Mises stress for models under posterior off-axis loading on one side; occlusal view. Scale applies to all plots in figure.

Discussion

Studies comparing tilted and nontilted implants have reached a relative consensus.[3,4,7,8,10,12] However, biomechanical evaluations of dentures supported by tilted implants revealed that several studies used different methods.[1,2,9,13,14,20,21]

In studies using finite element analysis, results change according to the method used and, mainly, to the point where force is applied for analysis. Considering the results of the denture that received axial loading on all teeth, we found that model 1 had the highest risk of fracture, with differences from 40 to 45%, which may be explained by the fact that it had the longest cantilever. However, as the cantilever was shortened, the distance between the posterior and anterior supports also increased, which changed the point under fracture risk. When only axial loads in the posterior region were analyzed, the size of the cantilever was proportional to the risk. This is the most predictable condition of all results because of the lever effect of the posterior extension. Under off-axis loading, results were similar, but less marked, probably due to force breakdown. The results on the bone around the implant showed that greater implant angles result in greater stress peaks when loads are applied to all teeth; that is, the vertical position of the implant favors stress distribution to a larger area and reduces stress concentration. Therefore, implant angle increases the risk of implant loss in dentures that receive loads on all teeth.

In 2009 Bellini et al[5] used a similar method to evaluate models with 4 and 5 interforaminal implants where

posterior implants had a 30-degree inclination and the prosthesis had a 5 or 15 mm cantilever. They also found greater stress concentration on tilted implants, which confirms our results.

In a study conducted by Bevilacqua et al[6], four implants were placed in the maxilla at inclinations of 0, 15, 30 and 45 degrees, and the length of the prosthesis was constant, as in our study. However, differently from our results, tilted posterior implants produced less stress concentration on bone around the implants, which may be explained by the different points of load application in the posterior region.

In a study conducted by Silva et al,[23] finite element analysis was used to compare the distribution of stress on maxillary fixed dentures supported by 4 and 6 implants, and with posterior implants placed at an angle of 45 degrees. They found that the presence of a cantilever significantly increased the levels of stress on the implant-prosthesis unit, which confirms the results reported here.

Conclusions

After the analysis of the framework of the prosthesis and loading according to the conditions used for the models in this study, the results of our simulations suggest that the model with vertical implants had the highest risk of fracture and that the highest degree of distal inclination of the posterior implants (30 degrees) promoted stress concentration on bone around the implant and, consequently, increased the risk of bone loss around the implants.

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

Dario Augusto Oliveira **MIRANDA***

Are short dental implants (< 10mm) effective? A meta-analysis on prospective clinical trials

Monje A, Chan HL, Fu JH, Suarez F, Galindo-Moreno P, Wang HL.
J Periodontol. 2012 Aug 23. [Epub ahead of print].

Background: This study aims to compare the survival rate of short (<10 mm) and standard (≥10 mm) rough-surface dental implants under functional loading. **Methods:** An electronic literature search using PubMed and Medline databases was conducted. Prospective clinical human trials, published in English from January 1997 to July 2011, that examined dental implants of <10 mm with a 12-month follow-up were included in this meta-analysis. The following data were retrieved from the included articles: the number of implants, implant dimensions, implant locations, types of prostheses, follow-up periods, and implant survival rates. Kaplan-Meier survival estimates and the hazard rates were analyzed and compared between short and standard implants. **Results:** Thirteen studies were selected, examining 1,955 dental implants, of which 914 were short implants. Short dental implants had an estimated survival rate of 88.1% at 168 months, when standard dental implants had a similar estimated survival rate of 86.7% (P = 0.254). The peak failure rate of short dental implants was found to occur between 4 and 6 years of function. This occurred at an earlier time point compared with standard dental implants, where the peak failure rate occurred between 6 and 8 years of function. **Conclusion:** This study shows that in the long term, implants of <10 mm are as predictable as longer implants. However, they fail at an earlier stage compared with standard implants.

How successful are small-diameter implants? A literature review

Sohrabi K, Mushantat A, Esfandiari S, Feine J.
Clin Oral Implants Res. 2012 May;23(5):515-25.

Background: Edentulism is an important issue and will remain so due to high numbers of edentate individuals worldwide. For many years, complete dentures have been the only treatment option for this population. Implant overdentures have been shown to have many advantages over conventional complete dentures. However, although dissatisfied with their mandibular dentures, some edentate elders are reluctant to undergo even simple implant treatment due to factors such as cost and fear of surgery. To address these obstacles, this paper reports on a review of small-diameter implant (SDI) studies that were performed in the last two decades.

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The aim of this study is to (i) determine the survival of narrow diameter implants, (ii) determine whether survival is dependent on whether these implants are placed using a flap or flapless approach, and (ii) determine whether there is a relationship between length and implant survival in SDIs. **Methods:** In this review, studies were included that (i) involve implants with 3.5 mm diameter or less, (ii) have a randomized clinical trial, retrospective or prospective cohort design with human subjects, (iii) provide a follow up duration of at least 5 months following implant placement, (iv) include data on the survival rate of the implants. **Results:** Forty one studies meeting the above criteria were published between 1993 and 2011 using SDIs from a variety of companies and surface characteristics with diameters of 1.8 mm to 3.5 mm and lengths of 8 mm to 18 mm. A total of 10,093 SDIs were inserted in approximately 2762 patients. Twenty-six studies involved flap reflection techniques for implant placement, six studies used a flapless technique and two studies used both techniques; in the remaining studies, the technique was not specified. Follow up duration varied from 5 months to over 9 years. The survival rate reported in all screened studies was over 90%, including eight studies in which a 100% survival rate was reported. In 22 studies, the reported survival rate ranged from 95% to 99.9%. Failure was reported most often in short SDIs (less than or equal 13 mm) (n = 88) compared to longer ones (more than 13 mm). **Conclusion:** Survival rates reported for SDI are similar to those reported for standard width implants. These survival rates did not appear to differ between studies that used flapless and flap reflection techniques. The failure rate appeared to be higher in shorter SDIs than in longer ones in the studies in which the length of the failed implants was reported. SDIs could be considered for use with fixed restorations and mandibular overdentures, since their success rate appears to be comparable to that of regular diameter implants. They might also be an efficient, low-cost solution for elders who wish to reduce problems with denture instability.

Peri-implant bone loss in cement- and screw-retained prostheses: systematic review and meta-analysis

de Brandão ML, Vettore MV, Vidigal Júnior GM.

J Clin Periodontol. 2013 Mar;40(3):287-95.

Aim: The aim of this systematic review and meta-analysis was to assess and compare peri-implant marginal bone loss in cement- and screw-retained prostheses. **Material and Methods:** Electronic database and manual searches were undertaken to identify trials, prospective or retrospective studies reporting on radiographic marginal bone loss around dental implants restored with cement- and/or screw-retained prostheses. Two reviewers independently conducted the article selection and data extraction. Random-effects models were used to obtain estimates of peri-implant marginal bone loss [mean, 95% confidence intervals (CI)]. **Results:** Of the 1217 identified studies, nine finally met the inclusion criteria. Only two studies included both cement- and screw-retained prostheses, three assessed only screw-retained prostheses, and four evaluated only cement-retained prostheses. Pooled mean marginal bone loss was 0.53 mm (CI 95%, 0.31-0.76 mm) for cement-retained prostheses and 0.89 mm (CI 95%, 0.45-1.33 mm) for screw-retained prostheses. **Conclusion:** There is no evidence to support differences in the marginal bone loss through indirect comparison between cement and screw-retained restorations.

Facial alveolar bone wall width — a cone-beam computed tomography study in Asians

Zekry A, Wang R, Chau AC, Lang NP.

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Background: The width of the facial alveolar bone wall is crucial for long-term successful esthetic outcomes of implants immediately placed into extraction sockets. A threshold of 2 mm is recommended to minimize buccal vertical bone resorption. **Aim:** To assess the width of the facial alveolar bone wall using cone-beam computed tomography images (CBCT). **Material and Methods:** Retrospective CBCT images were acquired from a representative sample of Asians using the i-CAT(®) classic system with a 0.4-mm voxel size. At random, 200 CBCT images were selected according to predefined criteria. The DICOM file was imported into the i-CAT Vision(®) software. In the panoramic screen, the middle of each tooth was selected, and in the sagittal window, the middle cross section was selected for performing the measurements using a computer. The vertical distance from the alveolar crest (BC) - cemento-enamel junction (CEJ) was measured. The width of the facial alveolar bone wall was measured at three locations: 1, 3, and 5 mm apical to BC. Descriptive statistics, frequency analyses, and multi-level comparisons were performed. **Results:** The sample consisted of 74 men and 126 women (mean age of 37.2 years; range 17-82years). A total of 3618 teeth were assessed. There was no significant difference between the values of right and left sides, or between genders. However, statistically significant differences were observed between age groups at all levels. The distance from CEJ to BC varied from 0.4 to 4 mm, with an overall tendency to increase with age. The mean width of the facial alveolar bone wall at anterior teeth was 0.9 mm and increased toward posterior regions. Rarely, a width of 2 mm was yielded (0.6-1.8% for anterior teeth, 0.7-30.8% for posterior teeth). At a 5-mm distance from BC, minimal widths of facial alveolar bone were identified for the anterior teeth. The frequency of dehiscence ranged from 9.9% to 51.6% for anterior and 3.1% to 53.6% for posterior teeth, respectively. **Conclusion:** A thin facial alveolar bone wall was usually present in both jaws. Hence, for most patients, adjunctive bone augmentation may be needed when installing implants in areas of esthetic concern.

The impact of cantilevers on biological and technical success outcomes of implant-supported fixed partial dentures. A retrospective cohort study

Kim P, Ivanovski S, Latcham N, Mattheos N.

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Objective: To investigate the biological and technical success outcomes of implant-supported fixed dental prostheses with and without cantilevers, after a minimum of one year loading. **Material and Methods:** One hundred and seven subjects with 128 cantilever FDPs (cFDP) supported by 132 implants were compared with 99 individuals with 144 non-cantilever FPDs (ncFDPs) supported by 203 implants. Outcomes such as marginal bone loss from FDP insertion to final follow-up as well as frequency and extent of biological and technical complications were investigated and correlated with patient, site, implant and FDP design characteristics. **Results:** The cFDPs were followed for average

of 51 months (1551 days, SD ± 977), and ncFPDs for 49 months (1483 days, SD ± 809 days). Implant survival and success rates were 96.7% and 87.9% for implant supporting cFDPs, and 99.5% and 92.6% for ncFDPs. There was no significant difference in overall bone loss between cFDPs and ncFDPs (cantilever side: 0.58, SD ± 1.16 - non-cantilever side: 0.59, SD ± 0.99), but implants in the cantilever group lost significantly more bone in the posterior mandible (0.50 SD ± 1.3 mm for cFDPs and 0.24 SD ± 0.80 mm for ncFDPs). Within the cantilever group, cantilever arm length and implant location had an influence on bone loss. Regardless of the presence of cantilever, implants associated with technical complications had a higher rate of biological complications as well. Furthermore, the length of the cantilever arm was positively correlated with implant failure, technical complications and bone loss ≥ 1.5 mm (P = 0.011, <0.001, and 0.007). **Conclusion:** Overall implants can be successfully used to support cantilever FDPs. However, there are technical and biological implications which appear inter-related.

Immediate occlusal loading of extrasinus zygomatic implants: a prospective cohort study with a follow-up period of 8 years

Migliorança RM, Sotto-Maior BS, Senna PM, Francischone CE, Del Bel Cury AA.

Int J Oral Maxillofac Surg. 2012 Sep;41(9):1072-6.

The aim of this study was to evaluate the long-term success rate of immediate occlusal loading of extrasinus zygomatic implants after an 8-year follow-up. From 62 patients who needed implant treatment in 2003, 25 patients who presented with maxillary atrophy met the inclusion criteria and agreed to participate in the study. All patients received fixed dentures under immediate occlusal loading supported by extrasinus zygomatic implants associated with anterior standard implants. No bone grafting procedures were performed. During the 8-year follow-up period, 21 patients underwent clinical evaluation and radiographic examinations every 6 months. This study conforms to the STROBE guidelines regarding prospective cohort studies. 40 extrasinus zygomatic and 74 anterior standard implants were evaluated. All patients were clinically free of signs and symptoms of sinus disturbance at all follow-up appointments. After 8 years, the success rates of extrasinus zygomatic implants, standard anterior implants and definitive prostheses were 97.5%, 95.9% and 95.2%, respectively. Within the limits of this study, immediate occlusal loading of extrasinus zygomatic implants presents a predictable treatment option for the atrophic maxilla.

Three-year clinical follow-up of a single tooth replacement with plateau design short implant

Rapp GE, Couto LM, Neri MA, Lisboa M, Speratti D

Aim: Osseointegrated dental implants are an effective alternative in the rehabilitation of partial or total edentulous patients. The aim of this clinical case is to present the replacement of a single tooth with limited prosthetic space using a plateau design short implant. **Material and Methods:** A 65 years-old female searched for a single tooth replacement at the 25 region (FDI notation) at the Federal University of Bahia-Brazil Dental School. She remained with an edentulous space during approximately one year. Due to the limited prosthetic space a 4X8mm (HA coated) locking taper (LT), plateau design (PD) and sloping shoulder (SS) implant has been selected (Bicon Dental Implants, Boston, USA). The implant has been placed 2.0 mm below the bone crest during surgical stage, following manufacturer's protocol. An Integrated Abutment Crown™ was taped in six months after implant placement. The occlusion has been checked and adjusted. **Results:** A three-year follow-up periapical radiographic image revealed no marginal bone loss. Clinically, the presences of aesthetically acceptable tooth-implant papillae and soft tissue contour were evident. The patient agreed in participating in the clinical case by means of a written consent. **Conclusion:** Properties as the bacterial seal of the LT and particularly, the lamellar bone formation at a supra-implant level as a consequence of the PD and the SS of the neck of the implant might have contributed to the bone quality at the supra-implant area. Thus, allowing sufficient space for papillae formation, in this clinical case.

Serum IgG levels to A. actinomycetemcomitans in Brazilian generalized aggressive periodontitis patients

Saraiva L, Rebeis ES, Mantovani NA, Holzhausen M, Mayer MP

Aim: Studies have examined the relationship between the distribuition of *A. actinomycetemcomitans* serotypes and periodontal condition; the prevalence of the *A. actinomycetemcomitans* serotypes may differ according to the geographical location and type of disease, and serotype c was shown to be highly prevalent in Brazil. The ability to induce disease and a strong immune response may also differ among the serotypes. This study investigated the sera IgG levels to *A. actinomycetemcomitans* in patients with generalized aggressive periodontitis. **Material and Methods:** Twenty six subjects presenting aggressive periodontitis, aged 19 to 35 years and three healthy negative controls were evaluated for serum levels of antibodies to *A. actinomycetemcomitans* serotypes a, b and c by enzyme-linked immunosorbent assay (ELISA). Sera were considered responsive to each serotype when the OD corrected values were > mean OD healthy + 7sd. **Results:** Data revealed that IgG levels were positive for *A. actinomycetemcomitans* in 6 of 12 afro descendant patients. Five of these positive patients had high antibodies titers to serotype b, including 3 responsive also to serotypes a and /or c. However, an immune response to *A. actinomycetemcomitans* was observed in 12 of 14 Caucasian subjects. Ten of these subjects were immune responsive to serotype b, including 4 sera responding also to serotypes a and/or c. Serum IgG antibody levels were significantly different among different serotypes of *A. actinomycetecomitans* of patients with GAP ($p < 0.01$). **Conclusion:** Response to *A. actinomycetemcomitans* serotype b was shown to be strongly associated with generalized aggressive periodontitis, especially among Caucasian aggressive periodontitis patients.

MTZ alone or with AMX in the treatment of chronic periodontitis: a 1-year double-blinded, placebo-controlled, RCT. Part II: Microbiological results

Faveri M, Feres M, Figueiredo L, Mendes J, Silva M, Soares G, Socransky S, Teles R

Aim: Previous studies have suggested that the adjunctive use of metronidazole (MTZ) or MTZ+amoxicillin (AMX) is beneficial in the periodontal treatment. However, the effects of these two therapies in changing the subgingival microbial profile have only been directly compared in a few short-term studies. Therefore, the aim of this randomized, double masked, placebo-controlled clinical trial was to evaluate the microbiological effects of the adjunctive use of MTZ or MTZ+AMX in the treatment of chronic periodontitis (ChP). **Material and Methods:** 118 subjects were randomly assigned to receive scaling and root planning (SRP)-only or combined with MTZ (400 mg/TID) or MTZ+AMX (500 mg/TID) for 14 days. Subjects received clinical and microbiological monitoring at baseline, 3, 6 and 12 months post-therapy. Nine subgingival plaque samples per subject were analyzed for their content of 40 bacterial species by checkerboard DNA-DNA hybridization. **Results:** No statistically significant differences on the microbial profiles were observed between the three groups at baseline. However, at 12 months post-treatment the red complex pathogens were statistically significantly lower in counts and/or in proportions in the two test groups, in comparison with the control group. In addition, the systemic antibiotics, especially MTZ+AMX, elicited a more striking increase in the proportions of the host-compatible microbial species ($p<0.05$). **Conclusion:** The adjunctive use of MTZ or MTZ+AMX offers microbiological benefits, over those obtained with SRP alone, in the treatment of subjects with generalized ChP. The added benefits of MTZ+AMX in changing the subgingival microbial profile were more evident.

Genetic linkage in Brazilian families with GAgP

Brett P, Mc Quillin A, Pinneda-Trujillo N, Rapp G, Tonetti M

Aim: The aim of this study was to test the linkage of candidate genes to periodontitis in three large 3-generation families. **Material and Methods:** A 6 site/tooth full-mouth probing was performed by a calibrated examiner in 58 pedigree members. The GAgP was found in two families (Fam1, Fam3) and the generalized form of chronic periodontitis in one family (Fam2)(AAP, 1999). Edentulous members were phenotyped according to the reported cause of tooth loss. Smoking was not present in the affected members. All the subjects were genotyped for markers D1S1595, Fcγ3A, Fcγ3B65, Fcγ3B36, D1S1679, D7S1802, IL6-1750, IL6-1363, IL6-572, IL6-174, D7S1802, IL13954 and VDR-312. MLINK and Simwalk2 2.91 were used for the multipoint parametric linkage (MPLA) and the non parametric linkage analysis (NPLA), respectively. **Results:** LOD scores above 1 were found for marker D1S1595, in the MPLA, in overall and in Fam3. Highly significant values were found for D1S1679 ($p=0.0084$) and D1S1595 ($p=0.0077$) in the overall NPLA. Fam3 showed significant linkage ($p<0.05$) for D1S1595 and D1S1679 in all five studied NPLA statistics. **Conclusion:** GAgP seem to be linked to Chromosome 1 in the studied families. Further studies need to be conducted in other family sets in order to confirm these findings.

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