Oral implantology today: surgical protocol, historical facts, diagnostic imaging, biomechanical notes

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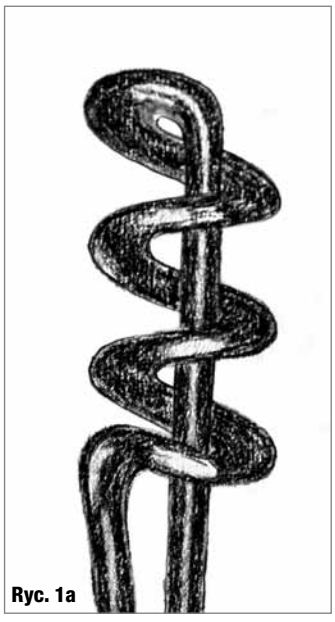
Summary: *The increase in life expectancy has led to an ongoing growth in partial or total edentulous patients. As a result, today's Oral Implantology is characterized by a huge expansion, development, and by the presence of various surgical schools. Consequently, many types of titanium implants are available on the market, characterized by different morphologies for the various surgical techniques applied. The implants that are available on the market can be simple screw in, self-tapping, blade, needle, cylinder, conical and so on. In this study we will provide a concise description of today's main surgical techniques, with the relative historical facts. We will also present some observations concerning personal clinical and radiological post- surgery check-ups on a group of patients, connecting them to some simple biomechanical concepts.*
Key word: *one-piece implant, immediate loading, electro-welding, biphasic implant, titanium bar.*

_Immediate Loading Technique

This is the classic technique, validated by almost seventy years of experience, where the implant is loaded immediately after its insertion into the bone.

A short time after the first world war, news of studies carried out by some overseas authors[1] based on the inclusion of metal elements into the bone to support prosthetics, led to a large amount of related research in Europe, using the most varied types of metals, which culminated in the first screws used by the Swede, Dahl, but also and especially to spiral implants created and positioned/inserted with favorable results by Formiggini in the 40's (Fig. 1a). This author, copied by some French surgeons, was met with indifference and even hostility by most of his colleagues. Only a long time after was a congress held in his honor in Modena. X-rays of Formiggini's implants, all fully functional, were presented. Even some of his patients, still using the implants without any problems or any conical reabsorption, a phenomenon which we will discuss later, were invited. Later, in the 60's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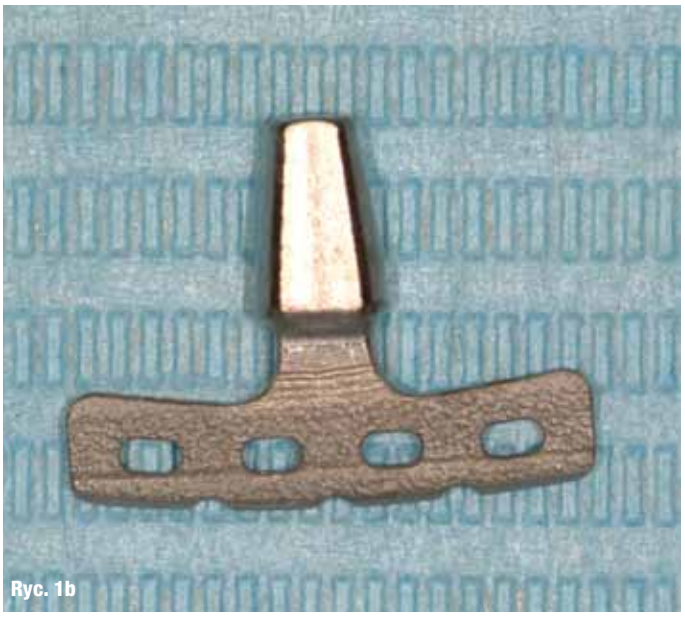
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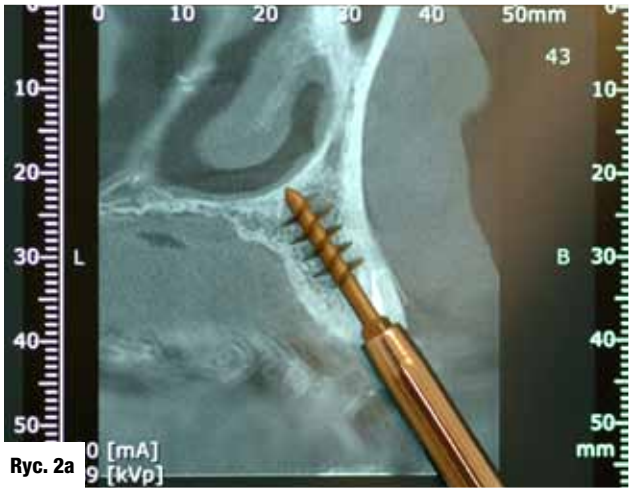
Fig. 1a_. Diagram of one of Formiggini's implants. b. Linkhow type blade implants.



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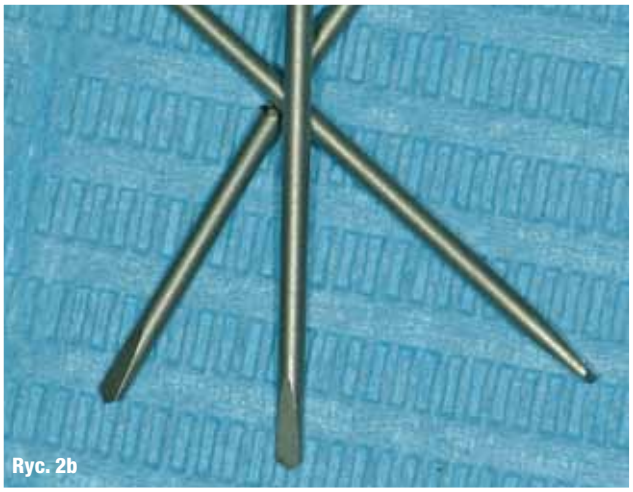
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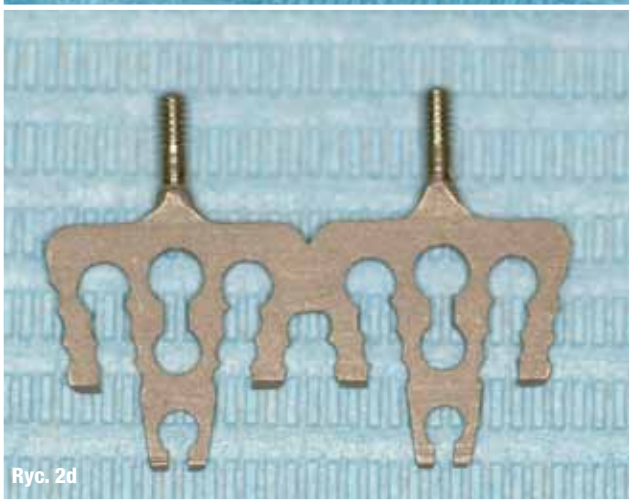

Ryc. 2d

Scialom's needles and the American Linkhow's[2] blades, all in immediate loading, appeared (Fig. 1b). These devices/tools were characterized by their simplicity and remarkable effectiveness, and they are still commonly used today in oral implantology, obviously modernized and updated compared to the needles and blades of over 40 years ago.

The immediate loading technique has therefore always been continuously perfected. Titanium was introduced, forms and procedures were studied and soon the high success rates arrived. The spread of this technique started in the 60's, thanks to a generation of implantologists, many of whom were Italian, who can be regarded as being among the founding fathers of implantology: we are talking about Muratori followed by Pierazzini, Tramonte, Garbaccio, Pasqualini and others, who brought implantology from empiricism to science. (Fig 2).

The concept remains the same, that is, the immediate functional loading of one piece implants (apart from Pasqualini's universal biphasic blade), (Fig. 3), which emerge from the edge of the alveolar in order to support the prosthetic immediately after surgery.[3]

It is in fact known that the healing/repair of bone tissue is aided by regular, functional activity, which in the oral cavity is represented by the action of the muscles used for mastication, swallowing and by the tongue.[4,5] Generally the principle is similar to that of the prosthetic rehabilitation of the hip or other osseo-articulatory segments, where passive and active movements are required from the first day after surgery, and immediately after controlled loading, according to Roux and Wolff's laws of 1892,[6] according to which it is the function/movement itself that will stimulate and remodel the bone.

There is however a drawback: the functional activity can cause micro implant movements which could be an impediment to the correct healing of the bone. The technique has therefore been improved in the course of time, so much so

Fig. 2a_One piece implants by the pioneers of implantology. b. Scialom's needles. c. Garbaccio's bicortical implants. d. Pasqualini's universal biphasic blades.

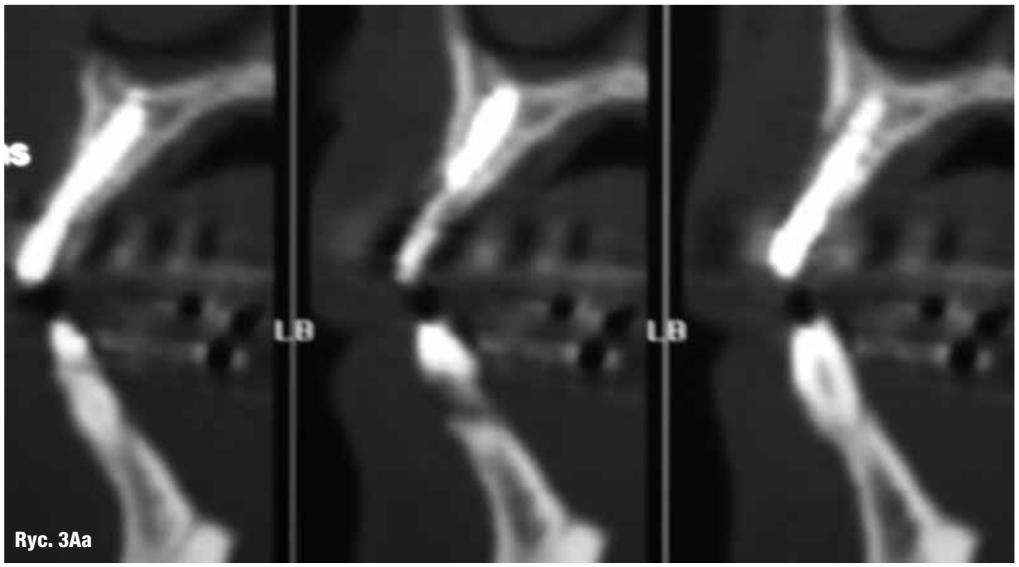


Fig. 3a_II level diagnostic study and insertion of one piece titanium grade 2 implants. Tilting and parallelization. b. Tramonte type monophase implants.

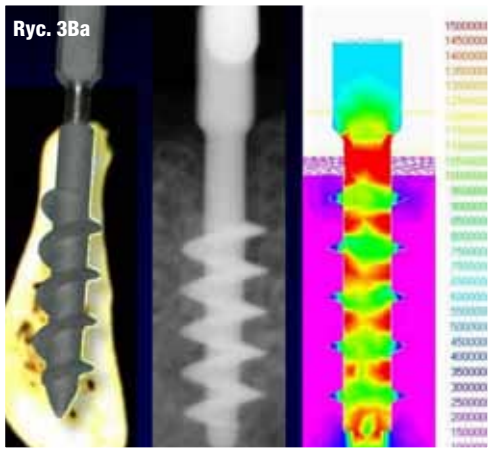
that today the emerging screws are fixed together by an electro welded bar (Fig. 4).

The bar reduces the micro-movements and stabilizes the implants (Fig. 5) which in this way lose their mechanical individuality, becoming a single, more resistant structure (Fig. 6).[7]

With immediate loading one piece implants, known as "mono-structural and emerging" are used. These devices, thanks to their morphology, are useful when exploiting particular bone recesses such as the canine pillar, the tuber, the pterygoid process (Fig 7), the pericanalare zone (Fig. 8) all important surgical resources in patients with maxillary or mandibular atrophy, for example in the elderly.[8]

_Deferred loading technique or two-phase

The year 1997 represents a particular year for oral implantology: it is in fact the year of Branemark's new theory, announced a long time after the appearance of self-tapping screws,



blades, and other state-of-the-art implants. According to this theory, to ensure a positive outcome to the operation, the so-called "osseointegration" is considered indispensable.[9]

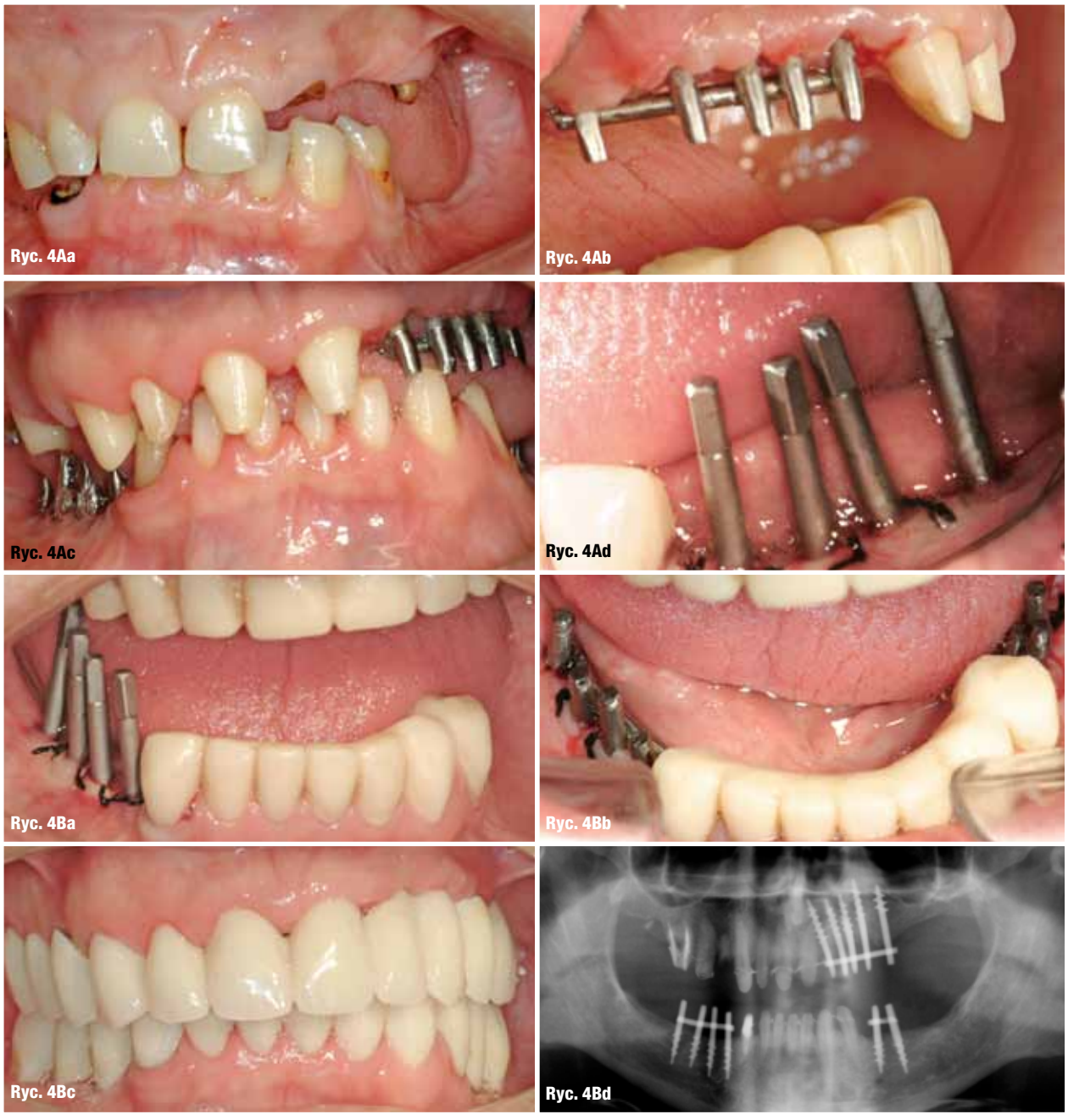
With this term the Swedish researcher wanted to define the close and direct contact between the surface of the implant and the vital bone tissue without the interposition of any connective tissue. Such integration, according to the author, would be possible only if the im-

plant is not subjected to immediate loading, but only after 4 to 6 months. Although Branemark showed method and scientific rigor, he undeniably claimed the opposite of what the classic implantologists do, and in open contrast to the experience of surgeons from other osseoartculatory sectors (Fig 9). The implants used in the two phase technique are built with two components.

The fixture, which represents the endosseous portion, inserted during the first surgery by means of bone tapping, and left to rest for 4 to 6 months: in most cases, the screw is very different to the one used in immediate loading as it is not self-tapping, does not have a tip, has a very fine thread but a wider diameter. The abutment or emerging stump, screwed to the fixture to support the prosthetic after the above-mentioned period of rest.

The implants are completed with the addition of the prosthetics and functionalized. The interval of several months between the insertion of the implant in the bone and its loading is the basics of the two-phase technique (Fig. 10). Despite being in total contrast with the validated implant methods to date, Branemark's technique

Fig. 4_Mono-phase post-extraction implants, welded and functionalized in the same surgical moment with a cemented prosthetic.



was very fortunate and still today many dentists, even university Professors, acknowledge that osseo-integration is the fundamental theory of implantology.

_Other proposed techniques

For some time now oral rehabilitation with two component implants in immediate loading have been proposed. In other words, this technique requires the use of the same implants as in two-phase surgery, strengthened and stabilized however by a bar and loaded immediately.

_Peri-implant bone reabsorption

It is worth briefly remembering what experience and research have demonstrated; that with time we often see alveolar bone reabsorption around the implant collar, on the level of the alveolar edge and this generally takes place in deferred loading implantology (Fig. 12).[11] This kind of reabsorption has a "conical" morphology and is considered acceptable within the limits of 1,5-2 mm in the first year, and of 0,2 mm for every successive year. Anything over those limits is considered pathological and one of the causes of the loss of the implant.

_Personal case studies

Our case studies are summarized in table 1. They involve 47 patients in bone class D2-D3 according to Misch-Adell-Branemark, 30 male and 17 female, with an average age of 52, divided into two groups: the first involves 21 subjects with 61 implants, rehabilitated using a two phase technique while the second group includes 26 patients, rehabilitated using the classic technique in immediate loading, with needles and self-tapping screws, solidarized and strengthened with a welded bar, for a total of 218 mono-structural, one-piece emerging implants.

Each patient was studied with a TC dental--scan before surgery and checked with a digital orthopantomography 12-24 months later. In 12 cases the post-surgery study, was completed by means of a TC Dental- scan.

While studying the post-surgery orthopantomograms carefully, our attention was caught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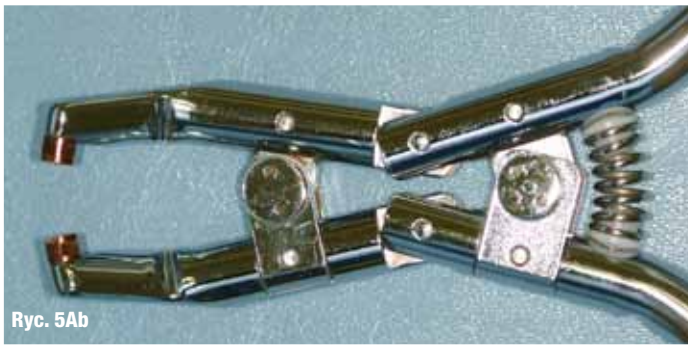

Ryc. 5Ab


Ryc. 5Ac

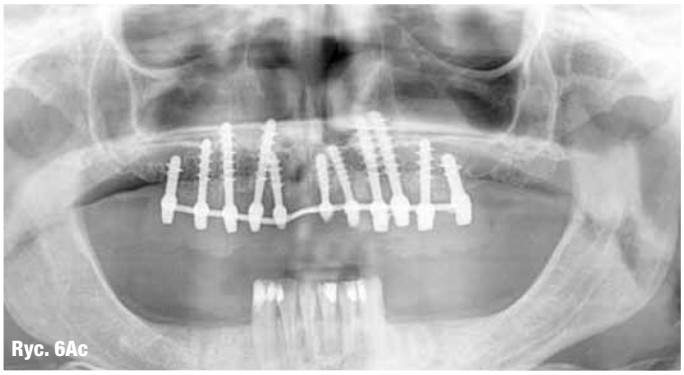

Ryc. 5Ba

Ryc. 5Bb

Fig. 5a_Mondani's Intraoral Welder, the electrodes are positioned on the surface of the abutment and the bar which, following sin-crystallization, will become a single entity. b. Several models of intraoral welders.


Ryc. 6Aa


Ryc. 6Ab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Ryc. 6Ad


Ryc. 6Ba


Ryc. 6Bb


Ryc. 6Bc


Ryc. 6Aa

mainly by pre-implant bone reabsorption, a well--known phenomenon that we have already mentioned. In particular we noticed that the bone reabsorption cone appears in 76% of patients in the first group (68% of the positioned implants), but only 23% in subjects rehabilitated with immediate loading (17% of the positioned implants).

In order to have a detailed analysis of the case studies, we prefer to postpone this to our next publication. However, in a preliminary study we can see a noticeable difference between the (long-term) results of the two techniques. This observation, only surprising in appearance, can be explained with relative ease if the radiological evaluations are connected to the a few simple, basic biomechanical notions, topics that we will consider very concisely further on.

_Diagnostic imaging and biomechanical correlations

First of all, it is important to stress that before any implant rehabilitation is carried out, even the simplest, it is necessary to request a TC-Dental scan.

This diagnostic exam is the only one able to provide information regarding the quantity of available bone and to classify the latter in a known category, based on its qualitative characteristics.[12]

Apart from being a unique diagnostic auxiliary, not to be considered lightly, the TC scan also has a relevant legal-medical bearing. In fact, in the case of litigation, it represents an element of defense for the dental surgeon who is, it is worth

Fig. 6a_Rehabilitation of the superior arch using the classic technique in immediate loading. There are 11 self-tapping screws, stabilized by a bar during the same surgical moment and functionalized immediately after. b. Mono-phase implant welded to a Scialom needle, in immediate loading. X-ray after 13 years.

remembering, according to present law, obliged by means and not by results.

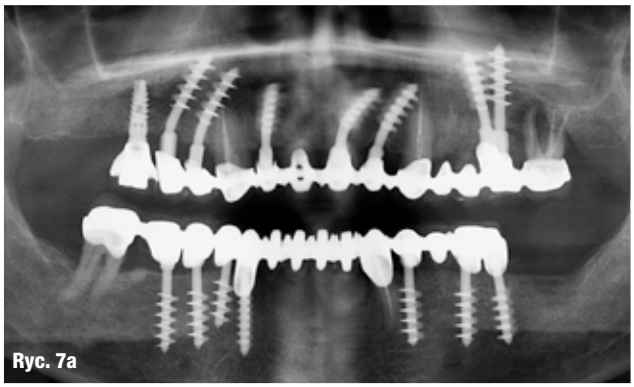
In the post-surgical phase, the digital orthopantomography is the main diagnostic exam for the patient's follow-up in time, because of its low dose exposure, the panoramic vision of all the masticatory apparatus, its ease of execution and the ample possibility of re-elaborating the images. And now let's move into a more technical field.

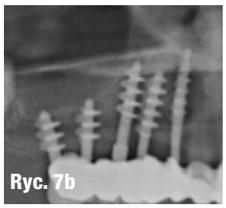
We have already said that one of the most frequent negative events observed by x-rays, in the check-up following the insertion of the implant, is the pre-implant conoid bone reabsorption. As well as some classic theories, which see bacterial infection as being the main cause of such reabsorption, today it seems much more likely that the biomechanical factor is the main cause due to its etiological prevalence.

Recently, many authors have illustrated that, unlike two-phase implantology, in immediate loading surgery the pre-implant conoid reabsorption is less frequent due to a better distribution of stress around the implant.[13] We also believe that with immediate loading bone reabsorption occurs more rarely. In fact in the x-ray documentation at 18-24 months only 1/4 of our patients who had been rehabilitated in immediate loading developed alveolar bone retraction, while in the patients who were treated with differed loading, the incidence of bone retraction was seen in ¾ of the cases. Such an evident and marked difference merits further study. We have therefore developed models with finite elements, based on our cases, evaluating the behavior of a single implant and those linked by a welded bar (Fig. 13). From our studies, the biomechanical element (that is, functional stress) reveals itself to be the main etiological factor in pre-implant bone absorption.

The difference in behavior between implants in immediate or deferred loading can be explained mainly by the distribution of stress in the

Fig. 7_The Canine Pillar and the tuber represent an excellent surgical resource for one-piece implants.





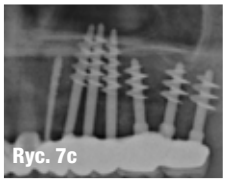
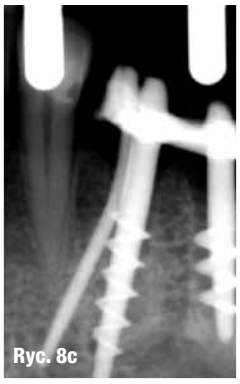


Fig. 8a_The morphology of one-piece implants allow, after a careful diagnostic check-up, for the delicate periforaminal zone to be exploited. b. Monophase implants and a Scialom needle, post extraction, welded and immediately functionalized. Check-up after 9 years.



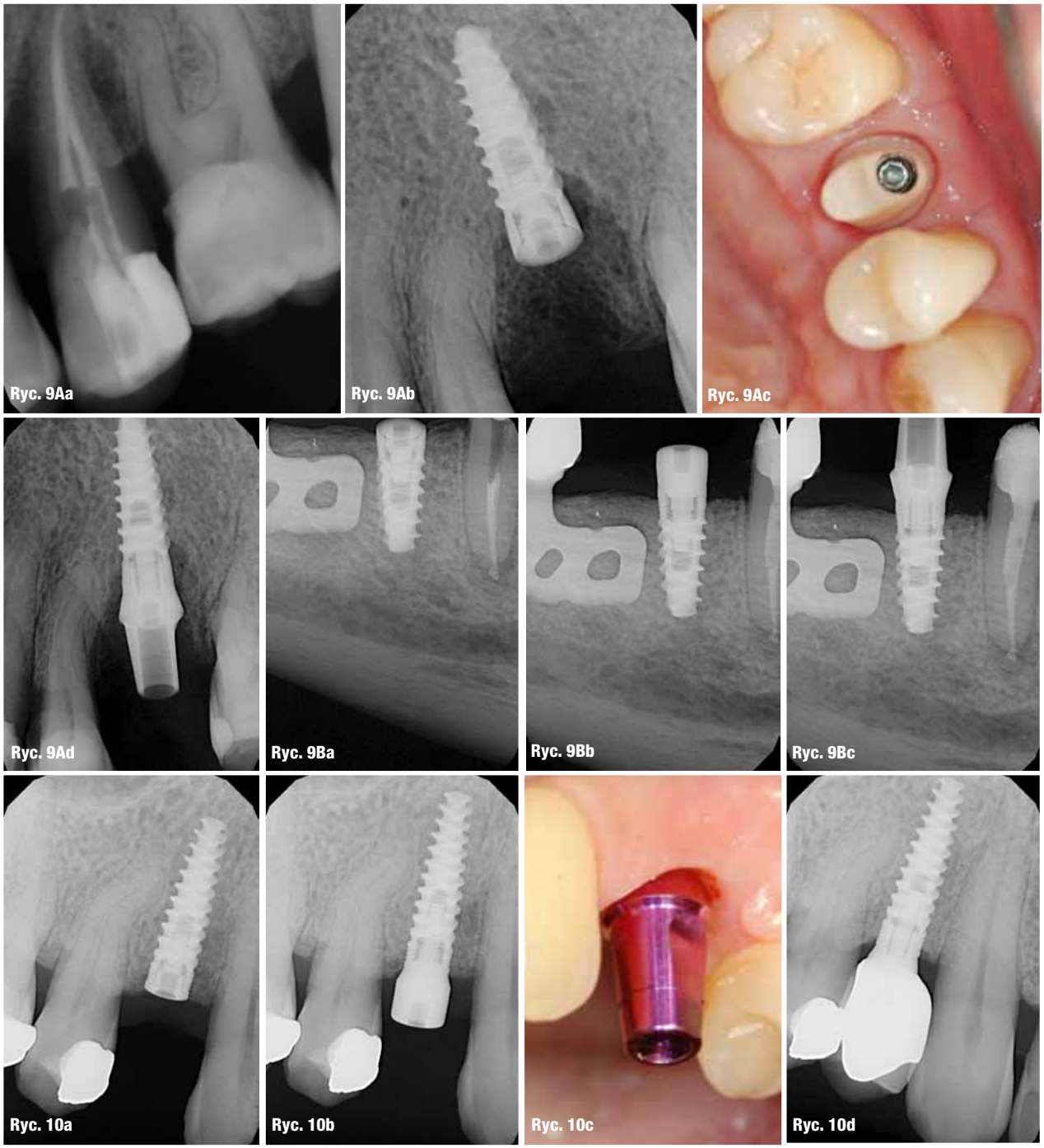


Fig. 9a_Rehabilitation with deferred loading; compared to classic/standard technique, the implants different morphology can be seen, with narrow threads, not self-tapping. b. A two-phase implant, hexagonal in shape, inserted next to a blade after 20 years. Three different steps: tapping screws, healing screws and, lastly, abutment.

Fig. 10a, b_Two-phase fixture. c. Provisional abutment inserted in the second surgical phase. Impression abutment, the successful gingival, cervical remodeling is visible. d. Definitive crown in intraoral x-ray.

contact areas between screws and cortical bone. Our studies highlight in fact how critical these zones are, given that they are subjected to the highest levels of stress. Such a phenomenon is to be considered the main cause of bone/cone reabsorption, recorded over time in the area (Fig. 13a).

In one-piece implants in immediate loading (self-tapping screws and needles), the analyses we carried out highlighted how a part of the active load on the implant is transferred from the bar to the outer implants. The direct consequences of this transfer, is a reduction in the maximum

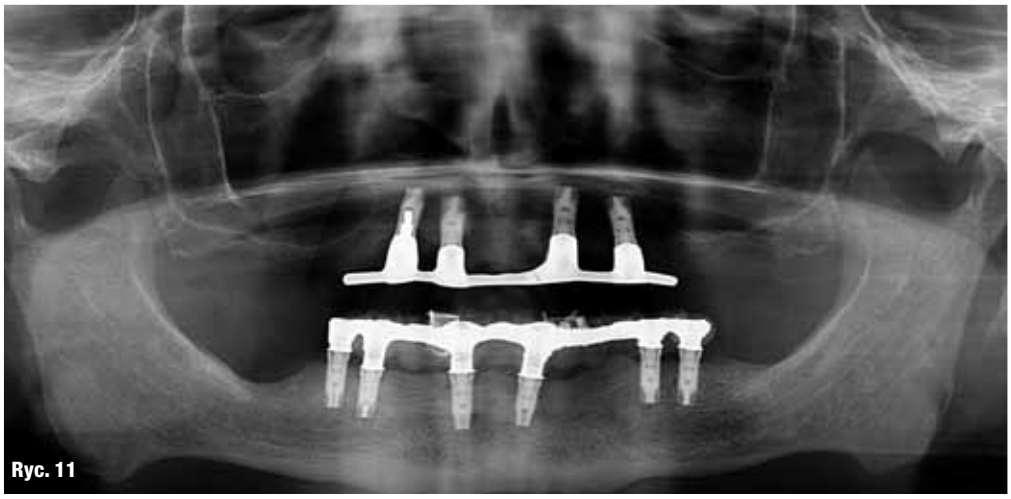
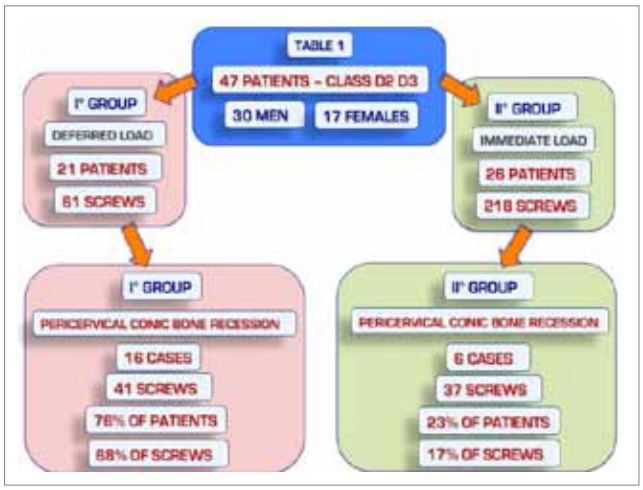


Fig. 11_A recent proposal: immediate loading on two-piece/component implants. The technique is still awaiting real/final validation.
Fig. 12_Peri-implant conoid reabsorption.



values of stress in the area of bone around the implant, which explains the better results in x-rays carried out after some months (Fig. 13b).

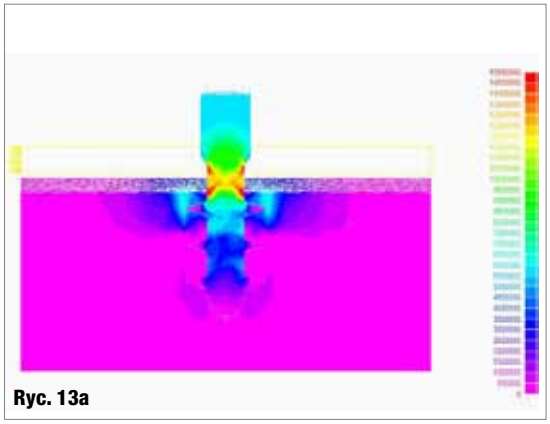
_Considerations

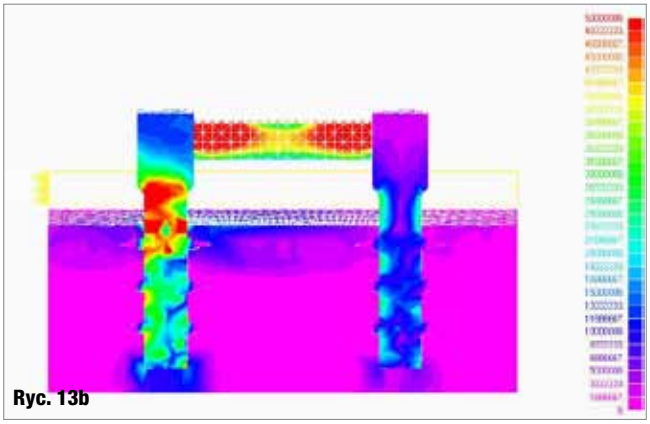
Today two main schools of implant surgery exist, with different procedures, some being in apparent contrast. Regardless of the technique adopted, the indispensable importance of x-rays is unquestionable, especially in the planning stage, and also for medical-legal reasons.

Regarding our case studies, we can affirm that in rehabilitation in immediate loading (as it is properly called) carried out, that is, with one-piece, emerging and strengthened implants, the alveolar bone reabsorption is radiologically less frequent than in the technique in deferred loading, at least according to check-ups after a set period of time. This should be considered mainly in relation to the distribution of functional stress in the contact zone between screws and cortical bone. Naturally, this observation does not allow us to automatically affirm that in the same subjects even the long term radiological results (10-15 years) will be better, but it gives us the right to legitimately consider this hypothesis.

Even other elements of the classic technique in immediate loading using mono-structural,

Fig. 13_Biomechanical models with finite elements. a. Deferred loading. b. Immediate loading explanations and text.





emerging implants, such as blades,[14] needles, self-tapping screws contribute to good, long-term results. We will mention them briefly, and they are the diameter of the threads, bi-corticalism, the diameter of the screw stem, and also of the bone density, the pressure applied to the bone, the condition of the drills, the speed of rotation, the possible influence of germs, the experience of the operator.[15-18]

A final consideration: given that both surgical approaches, advocates of apparently contrasting techniques, report high levels of success, it cannot be excluded that a large percentage of merit goes to the bone itself, being a highly adaptable tissue, capable of healing perfectly._

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