Pre-surgical digital diagnosis and planning in Guided Bone Regeneration (GBR): a clinical case report

Authors_Giacomo Tarquini*

*Graduated with honors in Dentistry and Dental Prosthetics from the University of Rome "La Sapienza." He currently practices privately in Rome.

_Introduction

The use of osseointegrated implants to support fixed prostheses has been a widely documented treatment for decades1-3.

In some cases, however, the presence of bone atrophy of varying severity affecting the maxillary and mandibular alveolar processes contraindicates or makes the insertion of endosseous implants impossible4 .

In order to correct these atrophies, various surgical techniques have been described in the literature, such as the harvesting and grafting of autologous bone in blocks5, 6, bone expansion techniques (or “split-crest”)7 and Guided Bone Regeneration (GBR)8 .

The most widespread and documented surgical approach is Guided Bone Regeneration, with success rates ranging between 92% and 100%9-11.

In particular, Guided Bone Regeneration (GBR) with the use of non-resorbable PTFE membranes is universally considered the intervention of choice for the treatment of horizontal, vertical or combined bone atrophy12.

The fundamental biological basis of GBR lies in the maintenance of a physical space beneath the membrane in order to stabilize the clot and to promote the creation of a compartment that remains separate from unwanted cellular lineages (connective tissue and epithelial cells) within which all phases of bone regeneration can take place undisturbed13, 14.

For this purpose, it is generally recommended to use PTFE membranes with a titanium reinforcement framework or, alternatively, non-reinforced PTFE membranes combined with a graft of a biomaterial of heterologous or autologous origin15.

With regard to the surgical protocol, it should be specified that in order to minimize the risk of postoperative complications, some technical measures are necessary to achieve adequate flap mobilization; for the same reason, particular attention must be paid to the suturing process, which aims to achieve and maintain stable closure of the surgical wound in order to ensure healing by primary intention16, 17.

To optimize the predictability of the final outcome, the diagnostic and pre-surgical planning phases are equally important. These are traditionally performed using first-level two-dimensional radiographic examinations and laboratory procedures such as performing a diagnostic wax-up of the teeth to be replaced and creating surgical templates. As an alternative to these procedures, it is now possible to use dedicated three-dimensional imaging software.

This work describes a clinical case of combined bone atrophy resolved with the insertion of osseointegrated implants associated with concurrent Guided Bone Regeneration (GBR) with non-resorbable PTFE membranes, whose pre-surgical digital diagnosis and planning phase was entirely carried out using three-dimensional reconstruction software.

_Materials and methods

The case of a patient (male, 57 years old) nosologically classified as ASA 1 and referred to our observation for implant-prosthetic rehabilitation of an edentulous area in the anterior mandible is presented (Fig. 1).

1st and 2nd level radiographic investigations (ortho-

pantomography and CBCT) show a marked combined type of bone atrophy (classifiable as grade 3 according to Seibert) which contraindicates the insertion of osseointegrated implants (Fig. 2).

Given the significant reabsorption of cre - this bone, to reduce the risk of intraoperative accidents - rators and be able to better plan the surgical intervention - gic, the positioning of 4 Resista IA3413 implants (Resista, Via F.lli Di Dio, 68 – Omegna, VCO) is simulated using the three-dimensional reconstruction software - sional Real Guide Ver. 5.0 (3Diemme, Como).

The implants are taken from the Resista library present in the Real Guide Ver. 5.0 software (3Diemme, Como) and positioned with the correct angle and depth in the atrophic crest to be rehabilitated: the re - three-dimensional construction provides for a partial exposition - position of the fixtures (Figs. 3, 4)

Based on the data obtained from the simulation, a Guided Bone Regeneration (GBR) procedure is then planned with non-resorbable PTFE membranes combined with a composite graft (made up of autologous bone particles in chips mixed with a biomaterial of heterogeneous origin).

logo) and the simultaneous insertion of 4 osseointegrated implants.

Antibiotic prophylaxis was started one hour before - but of the intervention (amoxicillin/clavulanate - co, Augmentin, Glaxo-SmithKline, Verona, Italy, 2 g 1 hour before surgery and then 1 g every 12 hours for 6 days).

Immediately before the session he operates - The patient was given rinses with 0.2% chlorhexidine digluconate (Corsodyl, Glaxo-SmithKline, Verona, Italy) to be continued for two weeks after the surgery at the rate of 1 rinse every 8 hours.

Napros was prescribed for pain relief - sodium sene 500 mg (Naprosyn 500 granules, Re - cordati, Milan, Italy) to be taken 1 hour before the surgical session and to be continued as needed, in a quantity not exceeding one sachet every eight hours for seven days.

After local analgesia obtained by infiltration - tion of articaine hydrochloride 40 mg with epinephrine 1:100,000 a full thickness trapezoid flap is raised to expose the intervening bone segment - ressed which shows a strong atrophy of the com - type stoned (Fig. 5).

Based on the data obtained from the simulation carried out with the Real Guide Ver. 5.0 software (3Di - emme, Como) we proceeded with the insertion of four endosseous implants measuring 3.5x13 mm. Resista IA3413 (Resista, Via F.lli Di Dio, 68 – Omegna, VCO) with the aim of optimising primary stability in the residual bone tissue: as foreseen by the pre-surgical planning - surgical, a large portion of the implant surface remains exposed (Figs. 6, 7).

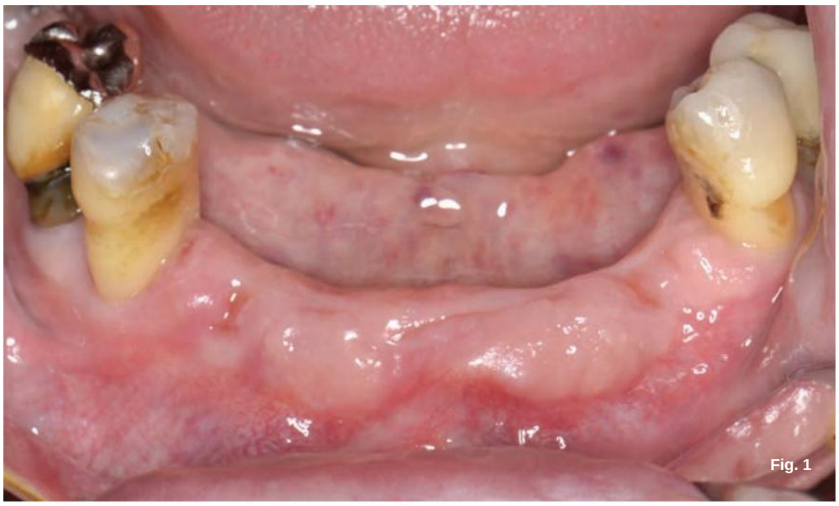
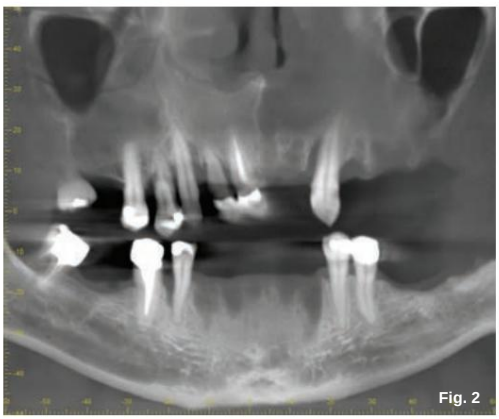


Fig. 1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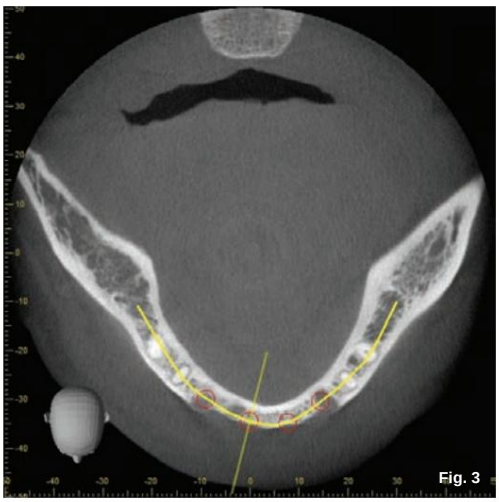
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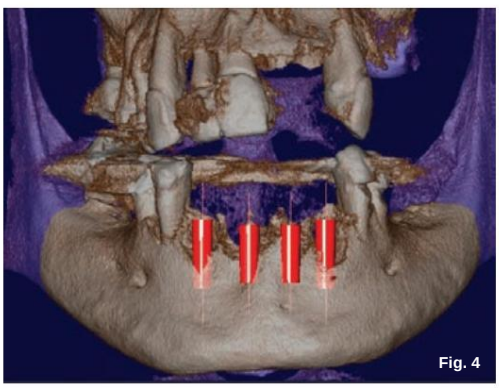


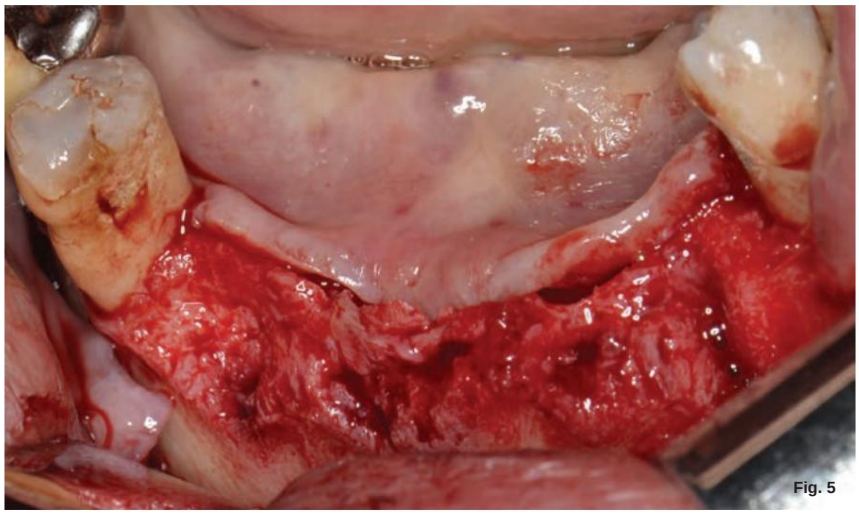
Fig. 4

Fig. 1_Preoperative image of the edentulous area.

Fig. 2_Preoperative Panorex-type reconstruction highlighting a combined bone defect in the mandible.

Fig. 3_Preoperative CBCT scan highlighting residual bone anatomy.

Fig. 4_Pre-implant simulation highlighting the limited bone availability in the vertical and horizontal directions.



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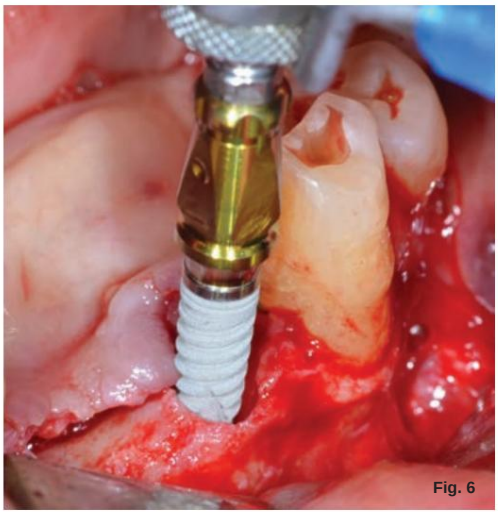

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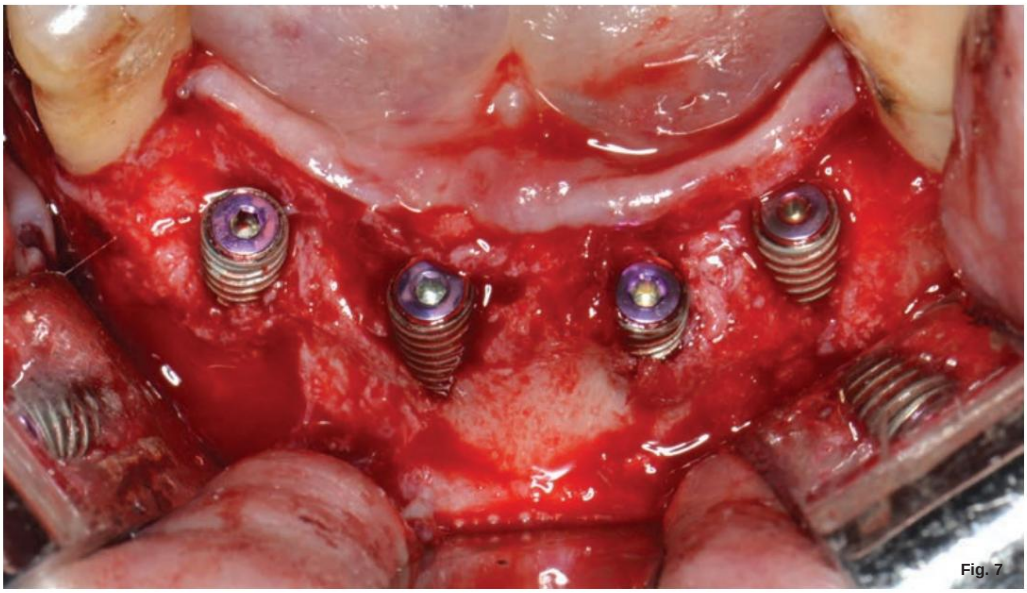


Fig. 7

Fig. 5_Skeletalization of the edentulous area.

Fig. 6_The macrogeometry of the implant (Resista IA3413) allows the stabilization of the implant even in highly atrophic bone crests.

Fig. 7_Insertion of 4 endosseous implants: a significant portion of the active surface remains exposed.

Two non-resorbable PTFE membranes measuring 25x30 mm. MED2530 Medipac (Resista, Via F.lli Di Dio, 68 – Omegna, VCO) are placed on the oral aspect of the atrophic ridge and securely fixed to the lingual cortex using 6 mm long VOS self-drilling osteosynthesis screws (Resista, Via F.lli Di Dio, 68 – Omegna, VCO) (Fig. 8).

A composite graft (made by mixing autologous bone chips collected using a bone shaver and a biomaterial of heterologous origin) is placed under the non-resorbable PTFE membrane and around the implant bodies (Fig. 9).

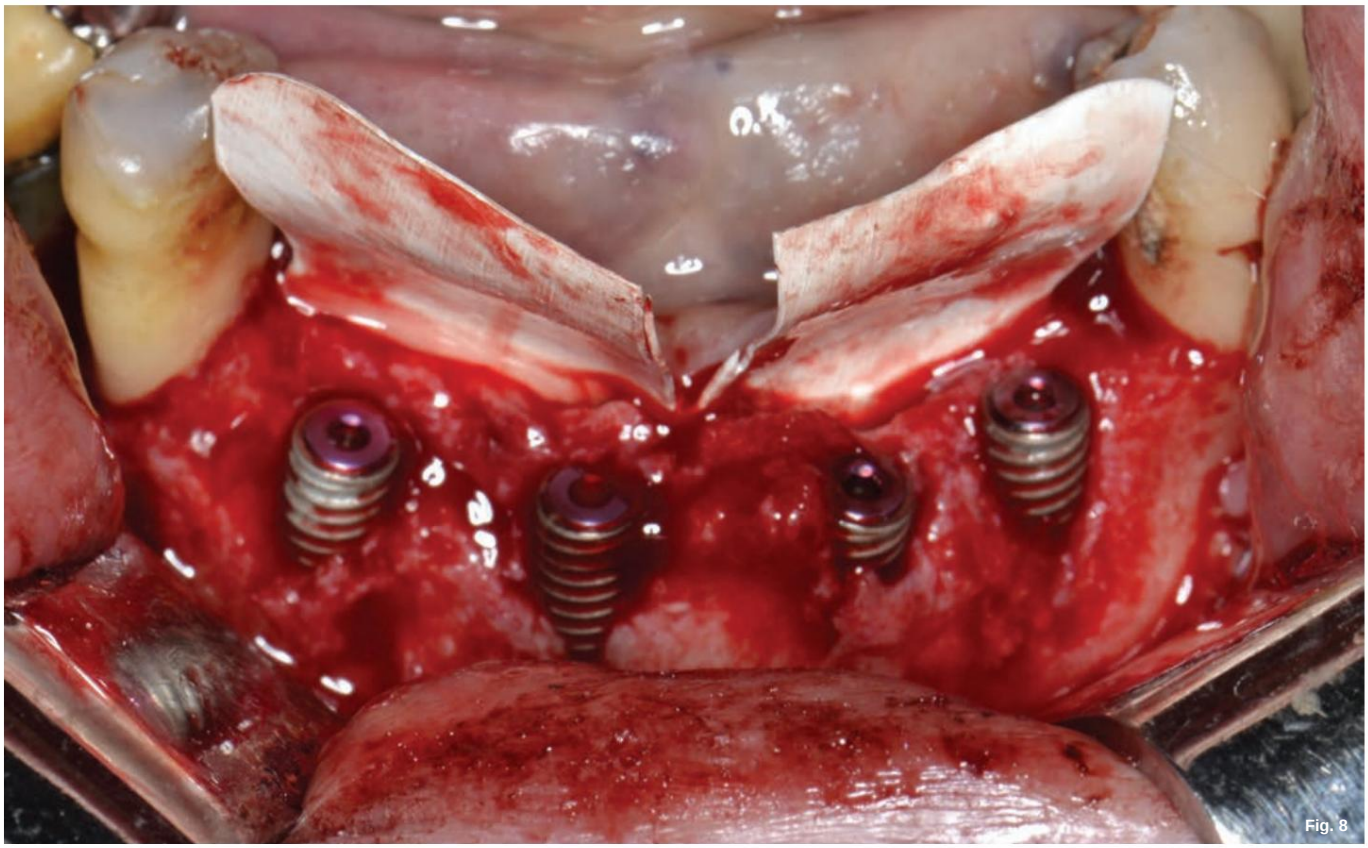
The membrane is reflected on the buccal aspect of the edentulous segment to protect the graft and fixed stably with 6 mm long VOS self-drilling osteosynthesis screws (Resista, Via F.lli Di Dio, 68 – Omegna, VCO) (Fig. 10).

The last stage of the operation involves the execution of a double line of suture with PTFE 4/0 Profimed thread (Resista, Via F.lli Di Dio, 68 – Omegna, VCO) (Fig. 11).

After an adequate healing period, surgical re-entry is performed and the synthesis devices and non-absorbable PTFE membranes are removed (Fig. 12).

Upon reopening, the intraoperative image reveals a substantial resolution of the peri-implant defects with abundant regeneration of newly formed tissue that, in some sites, reaches the head of the endosseous implant (Fig. 13). After appropriately conditioning the soft tissues using healing screws (Fig. 13), a definitive fixed metal-ceramic prosthesis is cemented onto the implant abutments (Fig. 14).

The radiographic control performed during the 12-month follow-up reveals optimal maintenance of the regenerated bone volumes and an evident corticalization of the peri-implant bone tissue (Figs. 15, 16).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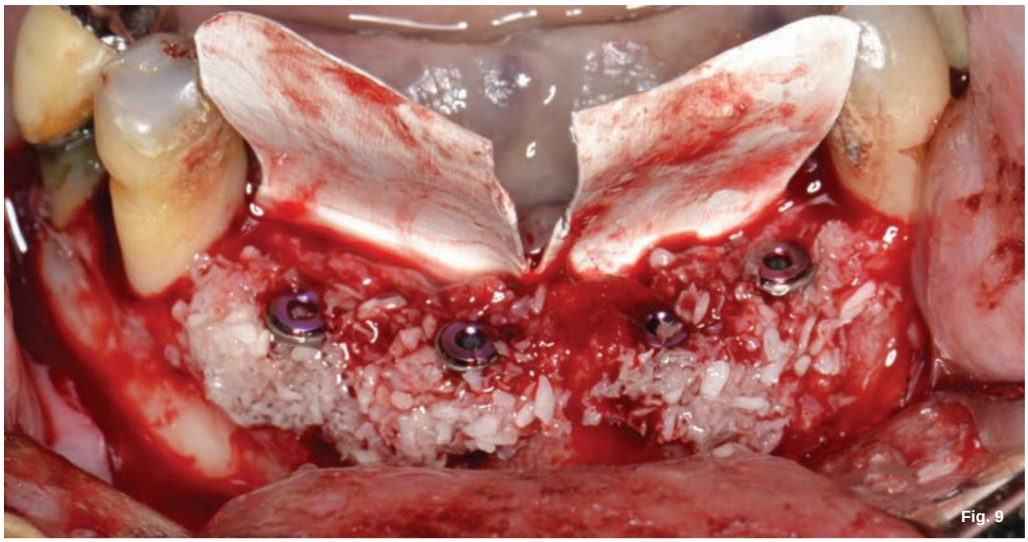


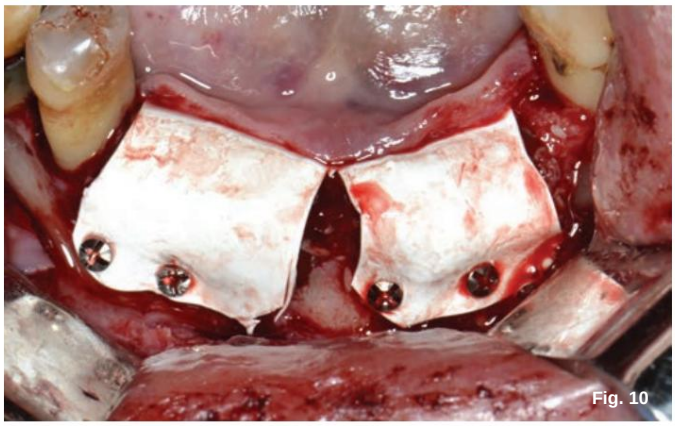
Fig. 9

Fig. 8_Positioning and fixation of two non-resorbable PTFE membranes on the oral side

Fig. 9_A graft composed of autologous bone chips and heterologous biomaterial is placed around the implants.

Fig. 10_The PTFE membrane is correctly positioned and fixed on the buccal side.

Fig. 11_Double line suture with 4/0 PTFE thread.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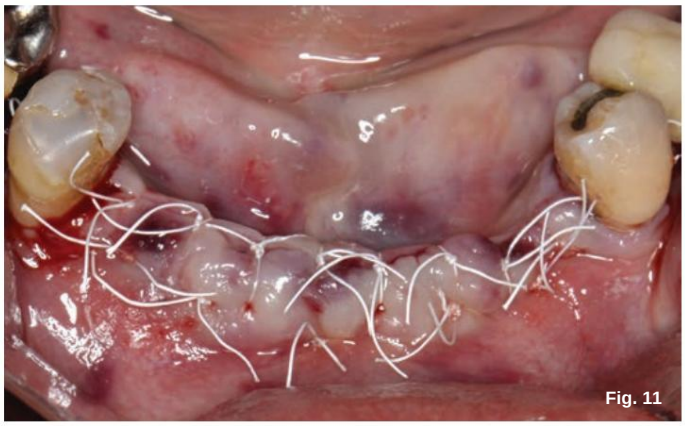
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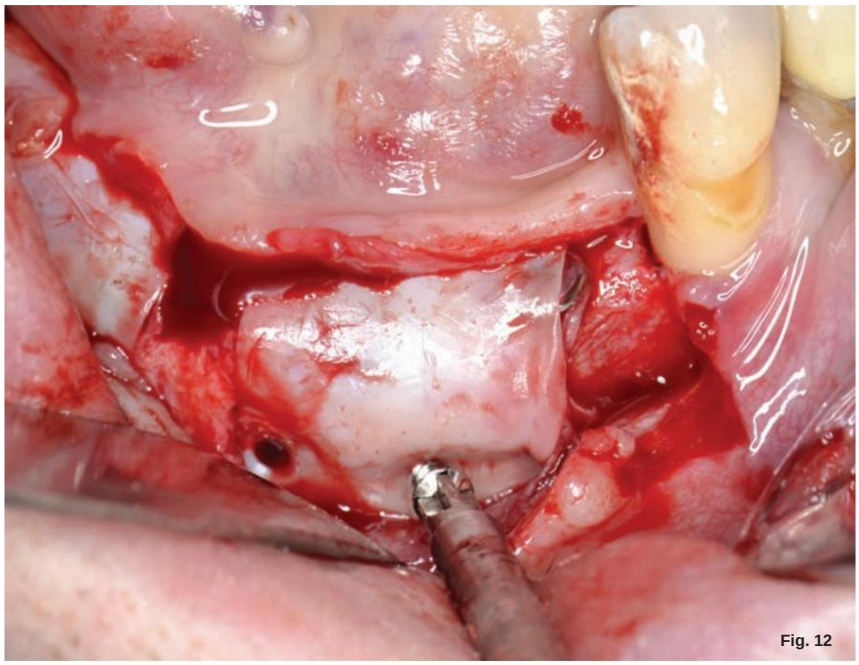
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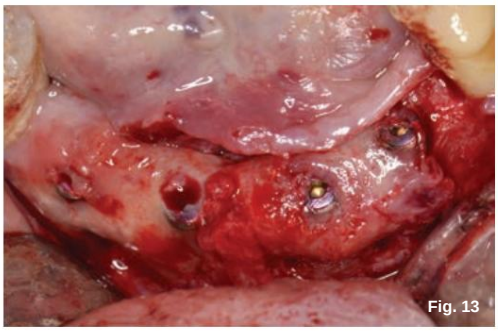
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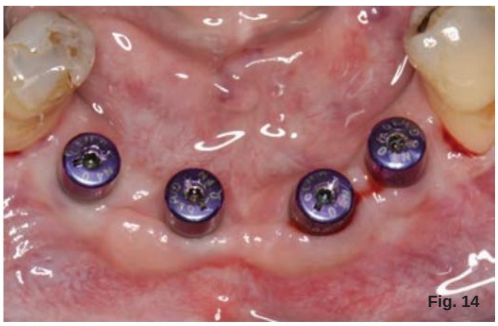
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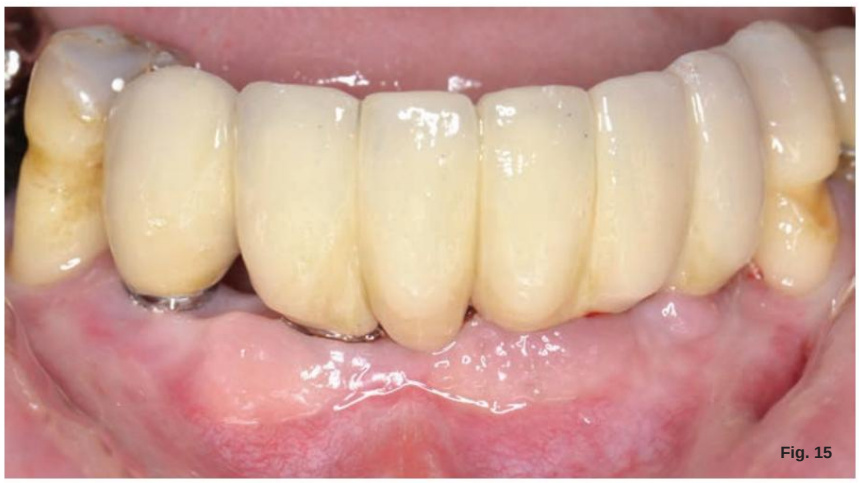
Fig. 15

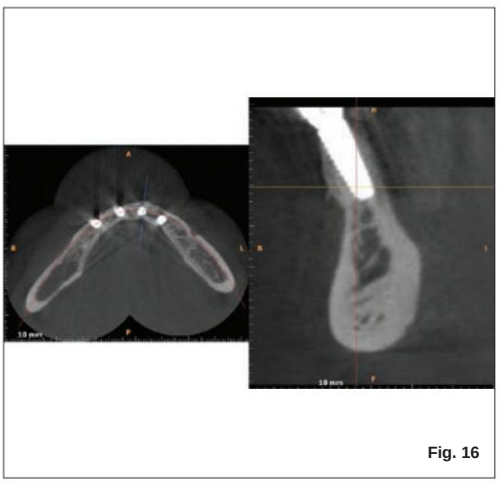
Fig. 16

Fig. 12_After an adequate healing period, the PTFE membrane is removed.

Fig. 13_A significant amount of newly regenerated tissue and the complete resolution of peri-implant defects are highlighted.

Fig. 14_Management of peri-implant soft tissues and conditioning of transmucosal tracts

Fig. 15_Definitive metal-ceramic prosthesis.

Fig. 16_12-month follow-up: postoperative CBCT examination demonstrates the presence of corticalized bone tissue at the implants.

_Discussion

Guided Bone Regeneration (GBR) using non-resorbable membranes is the surgical therapy of choice for the resolution of vertical or combined bone atrophy and has demonstrated over the years more than satisfactory results from both a clinical and histological point of view.

From a procedural point of view, it is important to remember that this surgical procedure requires the perfect execution of each operating step in order to avoid complications of various kinds.

The first and most important step in the therapeutic process undoubtedly lies in the diagnostic phase, with the aim of pre-visualising in three dimensions the anatomy of the atrophic edentulous ridge to be rehabilitated18.

This allows the clinician to identify and illustrate to the patient in an easy and understandable way any critical factors that could complicate the the treatment plan: it is clear that this possibility plays a crucial role in the information and motivational process that ultimately leads to the patient's acceptance of surgical therapy.

Once the diagnostic phase is completed, it is of fundamental importance to be able to pre-operatively plan both the correct positioning of the implants and the simulation of any bone defects that may be present, in order to evaluate the prosthetic parameters that will allow the choice of the ideal type of implant-supported rehabilitation, as well as to select and plan the elective surgical technique well in advance of the operating session19, 20.

From a surgical point of view, it should also be noted that in the presence of particularly severe bone atrophy, the choice of an ideal implant macro and microgeometry is essential to increase the

predictability of the final result: in the clinical case presented, the choice fell on implants characterised by a highly aggressive thread in order to optimise primary stability even in conditions of poor residual bone support and by a rough DAE Micro and Nano treated surface to favour regenerative processes, especially with regards to the large portion of the exposed implant surface.

It is evident that, compared to the past, when the planning of an implant rehabilitation was carried out exclusively by means of first level radiographic investigations such as, for example, the orthopantomographic examination (OPT) or intraoral radiographs, this task is today decidedly simpler and more accurate thanks to the use of specifically dedicated three-dimensional imaging software21.

A further advantage of this type of approach lies in its communicative impact on the patient: the ability to preview the initial anatomical condition and simulate the correct positioning of the implants allows each phase of the therapeutic process to be effectively conveyed to the patient in an understandable and immediate manner.

In the clinical case presented, the simulation of implant insertion using a three-dimensional diagnosis and design program revealed the presence of significant peri-implant bone atrophy: the ability to promptly detect and communicate this condition allowed the patient to be informed and motivated as well as to better plan the Guided Bone Regeneration (GBR) procedure with non-resorbable PTFE membranes.

Finally, it should be noted that clinicians faced with these new possibilities must in any case imperatively consider the relationship between the amount of information acquired, the benefits of communication with the patient, increased costs, and biological risk. It is therefore desirable for professionals to maintain a rigorously critical attitude regarding the real need for prescribing an additional test and its cost-benefit ratio.

_Conclusions

The integration of Guided Bone Regeneration (GBR) procedures with the pre-surgical diagnosis and planning capabilities offered by current 3D reconstruction software allows for extremely predictable results and significantly facilitates the ability to visualize, anticipate, and discuss any potential critical issues within the treatment plan with the patient. Furthermore, from a surgical perspective, the thoughtful selection of implants with appropriate macro and microgeometry is essential to improving the predictability of the final outcome.

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