

Clinical case letter

Immediate implantation and peri-implant Natural Bone Regeneration (NBR) in the severely resorbed posterior mandible using Leukocyte- and Platelet-Rich Fibrin (L-PRF): a 4-year follow-up

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1. Introduction

In the severely resorbed posterior mandible, the placement of dental implants in ideal position is often compromised by the significant post-extraction centrifuge alveolar bone resorption. The shape of the residual alveolar ridges and the residual bone height above the inferior alveolar nerve often make the area not suitable for direct implantation. Even if the use of short implants offers excellent results when the residual bone volumes are high and wide enough to receive these implants [1], there is no other solution than bone regeneration surgery prior to implant placement when the alveolar ridges are very thin [2]. However bone regeneration itself remains a challenge in this area, as the mandibular posterior residual alveolar ridges are always very cortical with a low vascularization and therefore not really adapted to the integration of bone grafting material or regeneration of bone cavities. Finally, the posterior mandible is a place of significant mechanical constraints applied on the bone and gingival tissues during the mastication function, and this can compromise the healing of a bone regeneration chamber, particularly through the risk of soft tissue dehiscence after the regeneration surgery.

To bypass these many traps and disadvantages, we tried to develop a new form of Guided Bone Regeneration (GBR) where both the bone and gingival compartments are reinforced and better controlled. The first element of this strategy is to use the dental implant itself as a space maintainer [3] and as a regeneration pillar to reinforce, protect and guide the bone compartment under the GBR barrier. This concept is termed Screw-Guided Bone Regeneration (S-GBR), and the implant is considered as an optimized screw (in comparison to more traditional osteosynthesis screws that can be used in this strategy).

The second element of this strategy is the use of an adequate combination of bone substitute and Leukocyte- and Platelet-Rich Fibrin (L-PRF). L-PRF is platelet concentrate for surgical use (Intra-Spin L-PRF system, Intra-lock, Boca Raton, FL, USA)[4]. After centrifugation of 10mL whole blood without anticoagulant, a L-PRF clot can be collected and contains most of the platelet aggregates, leukocytes and growth factors of the initial blood sample within a strong fibrin matrix [5]. L-PRF is an optimized blood clot. After compression in an adequate surgical box (Xpression kit, Intra-lock, Boca Raton, FL,

USA)[6], we can collect a strong membrane with many potential uses in periodontology and implant dentistry [7,8]. This membrane releases growth factors and healing proteins during more than 7 days in vitro and promotes cell proliferation and differentiation [6,9].

During bone regeneration surgeries, the use of L-PRF membranes accelerates soft tissue healing and prevents gingival dehiscence [10], thus protecting the bone regeneration compartment. It also stimulates bone tissue integration and remodeling [11]. This strategy of combining L-PRF with adequate materials is a form of in vivo tissue engineering and was termed Natural Bone Regeneration (NBR). In this article, we describe the use of L-PRF and simultaneous implantation in a NBR strategy for the treatment of a severely resorbed posterior mandible.

2. Materials/methods and results

A 49 years old female patient came to the implant consultation for a fixed implant-supported rehabilitation of her right posterior mandible. The 3 molars were extracted more than 6 years ago and the patient was wearing a removable partial denture. The patient was a moderate smoker (2 cigarettes per day) and in good general health. The radiographic examination revealed a significant resorption of the bone alveolar ridge in width (**Figures 1A, 1B, 1C**). The residual bone height was acceptable for direct implantation, but the width was much too slim to place implants in adequate orientation and position.

Using the implant planning software, we observed that an ideal direct implant placement would imply to leave the upper 6mm of each implant outside of the mandibular bone body (**Figure 1B**): only the lingual face of the implants would be in contact with the residual alveolar bone ridge. As the implant could be stabilized with their lower part within the residual bone, it was decided to perform a direct implantation with simultaneous peri-implant bone regeneration following the S-GBR and NBR principles.

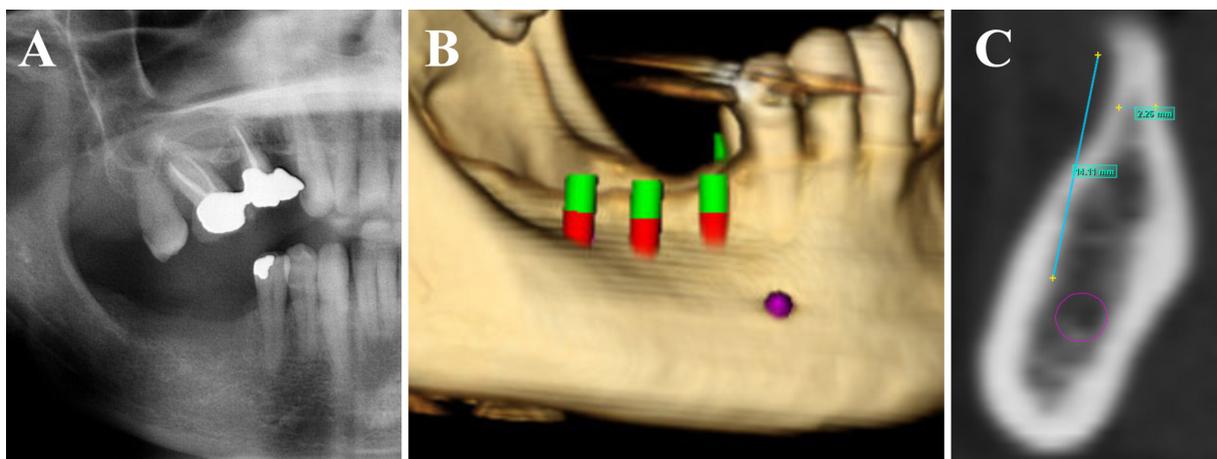


Figure 1. Radiographic examination of a resorbed posterior mandible before implantation. (A) On the panoramic radiograph, the residual alveolar height appeared suitable for implantation. (B) The residual bone ridge was very narrow and resorbed. A 3D planning for implants placement illustrated that in adequate positions, around 6mm of the implants length would remain mostly outside of the bone ridge. (C) The CT scanner reconstruction showed the slim shape of the upper half of the alveolar crest above the inferior nerve.

At the beginning of the surgery, L-PRF was prepared using the standard protocol and material (FDA approved/CE marked system marketed as Intra-Spin system and Xpression preparation kits, Intra-lock, Boca Raton, FL, USA) using 8 tubes of 10mL of whole blood. After centrifugation and collection of the L-PRF clots, 8 membranes were prepared for use at the end of the surgery.

The clinical procedure was performed using local anesthesia (**Figure 2A**). The surgical site was opened and confirmed the slim shape of the residual alveolar ridge (**Figure 2B**). The implant osteotomies were carefully marked using a piezosurgical device (Piezosurgery, Mectron s.p.a., Carasco, Italy) on the crest along the slim residual wall (**Figure 2C**). The choice of this instrument was justified by the need of a very accurate osteotomy to be able to block the implants in the small residual bone height: as the residual ridge was very cortical and slim, there was a significant risk of sliding, bone fracture and formation of a bone dehiscence with a classical osteotomy drilling. The piezosurgical cut allowed to remain easily in an appropriate axis and to control accurately the dimensions and position of the implant well [12]. The implant osteotomies were then finished using the same piezosurgical instrument, and the implant wells appeared homogeneous and accurate (**Figures 2D, 2E**), what was in this case a significant key for success.

Three implants (10mm x 3.3mm for the 2 anteriors and 8mm x 3.3mm for the posterior) were inserted carefully in their respective wells (Ossean, Intra-Lock Inc., Boca Raton, FL, USA), and 5 to 6mm of the upper part of the implants remained out of the residual alveolar ridge (**Figure 3A**). Only the lingual face of the implant was in direct contact with the osteotomy walls all along. It could be noticed the precision of their axis, and the spaces between implants were chosen to have the implant heads in position of tent pegs for the bone regenerative chamber (**Figure 3B**).

The next step of the NBR strategy was to perforate the cortical bone by drilling 12 holes with a round bur all over the buccal wall of the residual alveolar ridge, following the principles of endosseous stimulation (**Figure 3C**). This trans-cortical bleeding was a key for the vascularization of the bone regeneration compartment and the proper integration of the bone grafting material. The vestibular face of the alveolar ridge was then covered with a mix of L-PRF and collagenated equine bone material (Gen-Os, OsteoBiol, Tecnoss, Turin, Italy) in a 50/50 volume ratio, in association with a 0.5% metronidazole solution (**Figure 3D**). All the threads of the implants were largely covered with a significant quantity of material to regenerate a broad alveolar ridge around them.

Three layers of L-PRF were finally added to cover the surgical site and maintain the bone material (**Figure 3E**). Following the NBR principles, these membranes were used as competitive interposition barrier to protect and stimulate the bone compartment, and as healing membranes to stimulate the periosteum and gingival healing and remodeling. Periosteal incisions were done on the flaps to promote their tension-free closure. The surgical site was sutured with non-resorbable sutures (silk 4.0, Hu-Friedy, Chicago, IL, USA) (**Figure 3F**). A post-surgical panoramic radiograph showed the adequate position of the implants and the grafted area appeared slightly radio-translucent (**Figure 3G**). Sutures were removed after 12 days. The post-surgical follow-up was uneventful.

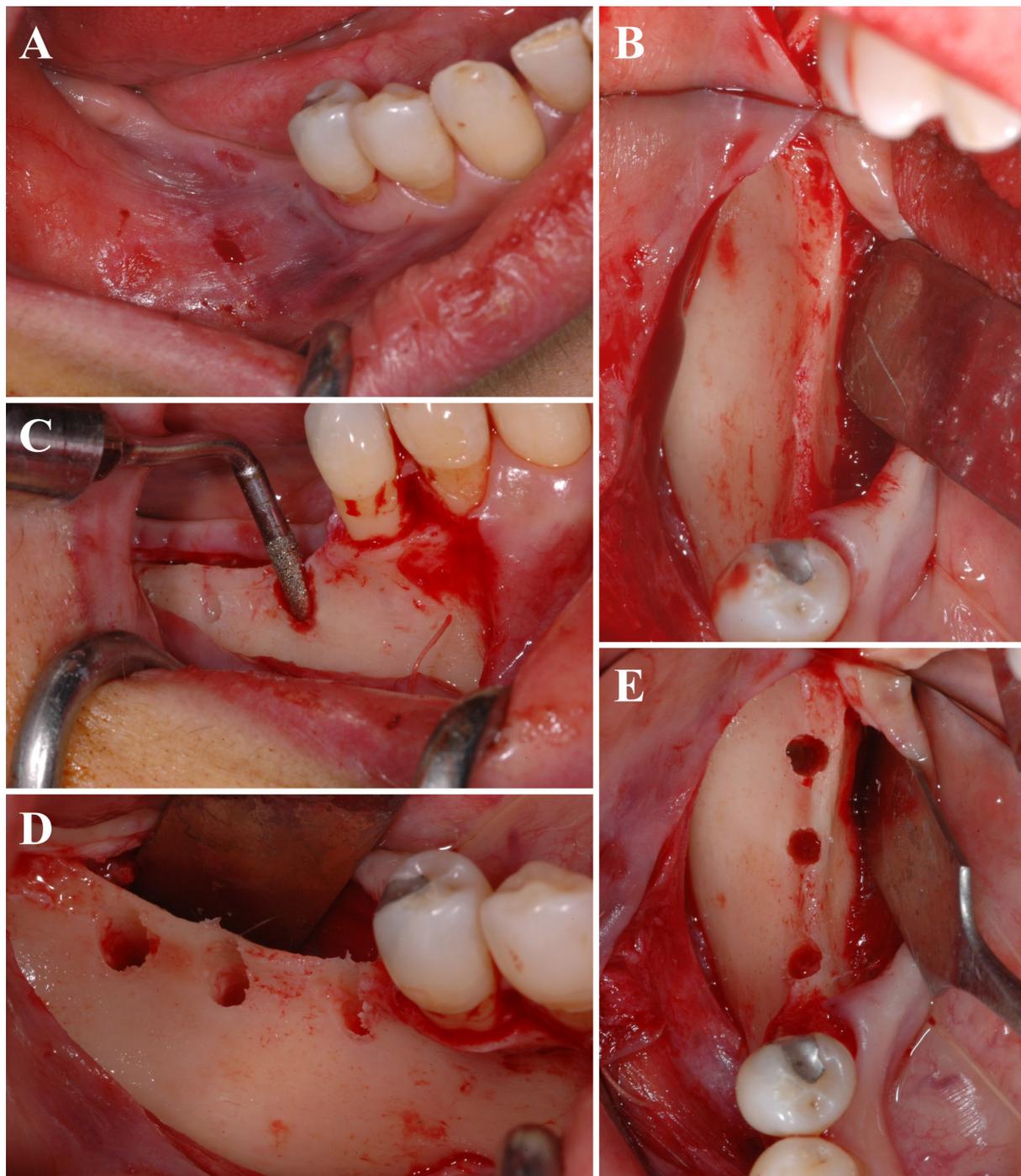


Figure 2. Simultaneous implantation and NBR in the resorbed posterior mandible: osteotomy phase. (A) Initial situation. **(B)** The alveolar ridge was very narrow. **(C)** The implant osteotomy positions were carefully marked along the narrow crest using a piezosurgical instrument. **(D, E)** The implant wells were prepared with the piezosurgical lancet in order to obtain a very accurate and non traumatic osteotomy.

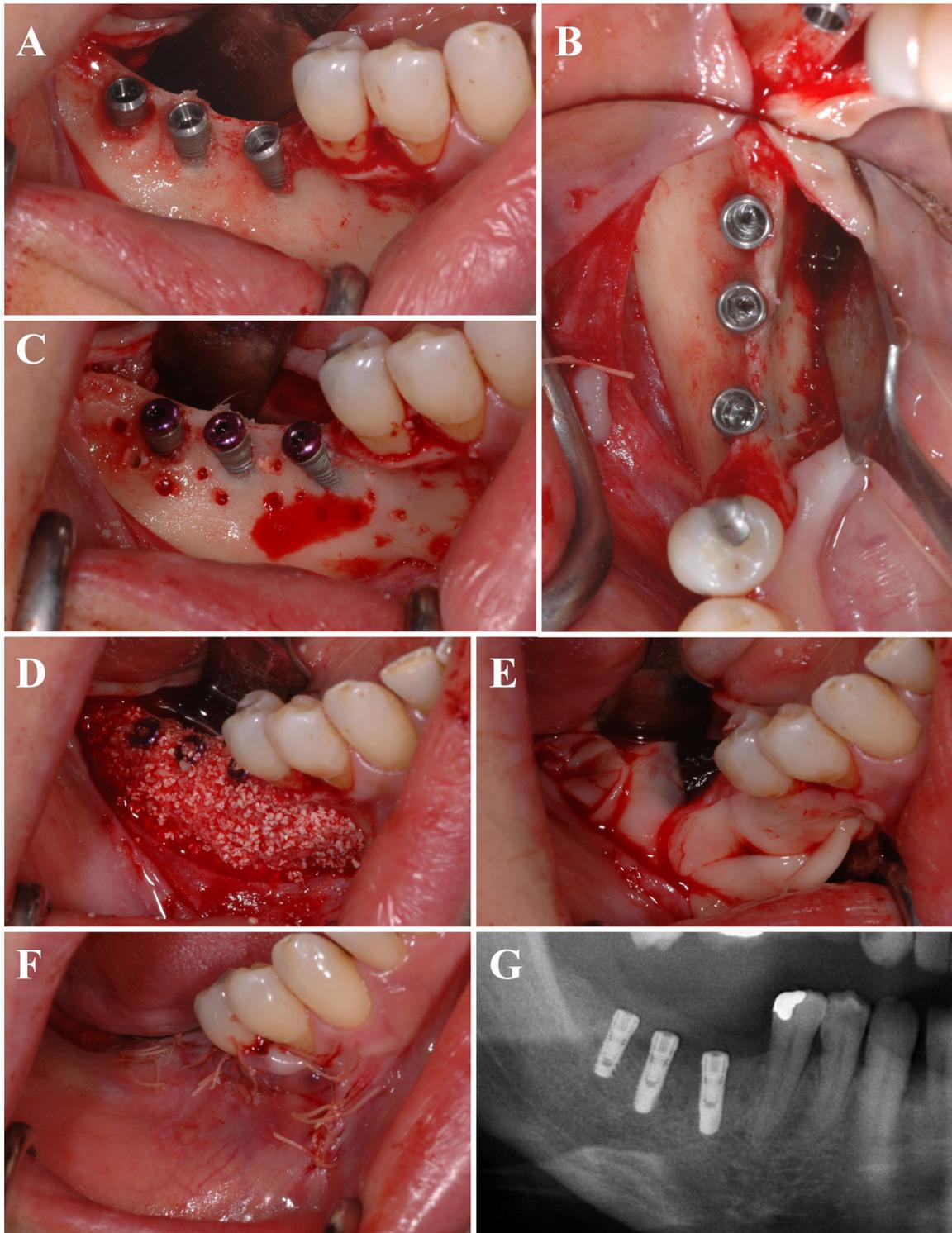


Figure 3. Simultaneous implantation and NBR in the resorbed posterior mandible. (A) Three implants (Ossean, Intra-Lock, Boca-Raton, FL, USA) were inserted. Their vestibular faces remained 5-6mm out of the bone ridge. **(B)** The implant collars were in direct contact only with the buccal wall of the narrow residual alveolar ridge. **(C)** Twelve endosseous stimulations holes were drilled with a round bur. **(D)** The vestibular face of the alveolar ridge was grafted with a mix of L-PRF and collagenated equine xenograft bone (Gen-Os, OsteoBiol, TecnoSS, Turin, Italy) in a 50/50 volume ratio, in association with a 0.5% metronidazole solution. **(E)** Three layers of L-PRF membranes were added on the grafted area in order to protect the bone material and to stimulate periosteum and soft tissue healing and remodeling. **(F)** Periosteal incisions and tension-free sutures were done. **(G)** Post-surgical panoramic radiograph.

Four months after surgery, the keratinized gingival tissue above the implants appeared thick and strong (**Figure 4A**), and the trans-gingival healing screws could be connected. A few weeks later, the screws were removed and the gingival tissue appeared thick and healthy on a quite broad regenerated alveolar ridge, without dehiscence (**Figure 4B**). The final implant-supported bridge was placed. The clinical and radiographic follow-up was organized each 6 months during the first year and then each year. Four years after the treatment, the rehabilitation appeared stable, functional and esthetic (**Figure 4C**). The radiographic follow-up did not show any significant peri-implant bone loss. The peri-implant tissues remained at the same level around the implant collars, and no dehiscence appeared (**Figure 4D**).

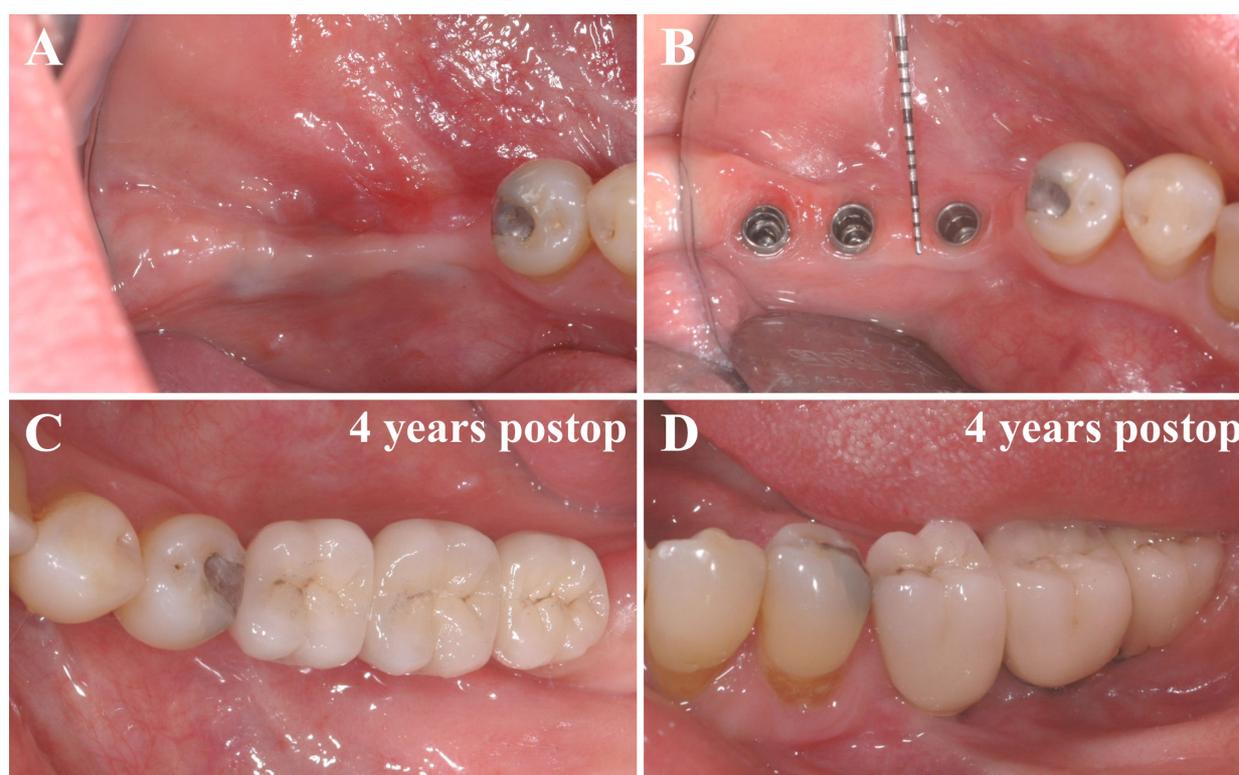


Figure 4. Prosthetic phase and follow-up. (A) Four months after surgery, the keratinized gingiva above the implants appeared thick and mature. Trans-gingival screws were connected. (B) After healing, the regenerated alveolar ridge was quite broad and covered with thick gingiva. The implant-supported bridge was placed. (C) Four years after treatment, the rehabilitation was stable and functional. (D) Tissues around the implant collars appeared stable. No bone loss or gingival dehiscence was observed.

3. Discussion

The general concept of NBR is to promote the simultaneous regeneration of the bone compartment and the gingival tissue above, through the use of L-PRF membranes as interposition and healing material: this is the synchronized regeneration principle. On one side, L-PRF stimulates early wound closure and longer-term gingival maturation [10], thus protects the bone compartment; on the other side, L-PRF supports the bone growth in the bone chamber [11].

In the NBR strategy, the bone grafting material is in general mixed with a L-PRF clot cut in small pieces, following a 70/30 or 50/50 volume ratio. The objective of this mixture is to help the rapid vascularization of the bone grafting material through the veins of L-PRF fibrin matrix making the bridge between bone particles and allowing a quick new bone growth, while the xenograft material serves as space maintainer for the regenerative volume and supports the nucleation and accumulation of newly formed bone matrix. The concept of the NBR strategy is to promote a complete remodeling of the bone materials and to regenerate *in fine* a natural bone volume. For this reason, the choice of the bone material to associate with the L-PRF is a key element of the definition of the technique. As the literature about bone materials is very controversial and commercial [13], there is no real consensus on the adequate material to use. However, following our experience, the NBR functions in priority with collagenated bone materials, and the material used in this case is commonly employed in our NBR surgeries.

In this case, the choice of the implant may have also a significant impact on the final clinical outcome. Indeed, in this concept of S-GBR, the implant functions as a regenerative pillar and should be an ideal optimized screw for bone growth and regeneration. Therefore, care must be taken to select an implant with an adequate macrodesign and surface which must be at least osteoconductive and maybe osteoinductive [14]. Implant with surface pollutions must be avoided. In this case, we used a microrough implant with a Calcium Phosphate low impregnation and nanoroughness, with validated surface patterns and biological properties (Ossean surface)[15]. This probably contributed to the excellent results which have been observed with this protocol since more than 5 years.

As a conclusion, the NBR concept gives promising results and is the natural complement of the S-GBR principles. These concepts must now be validated on longer-term and with large series. The choice of materials to combine with L-PRF in these strategies remains an important research question.

Disclosure of interests

The authors have no conflict of interest to report.

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