Clinical case letter

The concept of Screw-Guided Bone Regeneration (S-GBR). Part 2: S-GBR in the severely resorbed preimplant posterior mandible using bone xenograft and Leukocyte- and Platelet-Rich Fibrin (L-PRF): a 5-year follow-up

Roland Toeroek,[1,*] and David M. Dohan Ehrenfest.[2]

[1] Private Practice, Nuremberg, Germany.
[2] LoB5 unit, Research Center for Biomineralization Disorders, School of Dentistry, Chonnam National University, Gwangju, South Korea. Department of Stomatology, Oral Surgery, and Dental and MaxilloFacial Radiology, School of Dental Medecine, University of Geneva, Geneva, Switzerland.

*Corresponding author: Roland Toeroek, roland.toeroek@gmx.de

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1. Introduction

The treatment of the severely resorbed posterior mandible is always a challenge. Even if many therapeutic options have been tested with success using various forms of distractions **[1]**, osteotomies **[2,3]** or Guided Bone Regeneration (GBR)**[4]**, they all remain difficult to use and there is no consensus. It remains difficult to obtain a proper integration of a regenerated bone volume on the very cortical bone of the mandible body.

A specific form of GBR was developed using screws as space maintainers and regenerative pillars for the protection and bone growth orientation of the bone regenerative compartment, and was termed Screw-Guided Bone Regeneration (S-GBR). This approach appeared particularly adapted to the posterior mandible sites, as the screws are efficient support and protection for the bone regenerative chamber against the various mechanical constraints. This form of GBR can be associated with non-resorbable or resorbable membranes and various combinations of bone materials **[5]**, but the use of Leukocyte- and Platelet-Rich Fibrin (L-PRF, Intra-Spin system, Intra-Lock, Boca-Raton, FL, USA)**[6]** membranes became a very logical addition to any S-GBR protocol **[7,8]**.

L-PRF is an optimized blood clot concentrating most of the platelets and half of the leukocytes from a 10mL blood sample **[6,9]**, and promotes healing through the release of growth factors **[10]**. After compression in a specific box (L-PRF Xpression kit, Intra-Lock, Boca-Raton, FL, USA), we can obtain easily large numbers of these membranes **[11]**. The fibrin membrane is particularly helpful to protect a surgical site and promote quick wound closure **[7,8,12]**, and is therefore an interesting addition to S-GBR strategies were the risk of soft tissue dehiscence and bone chamber contamination remains the main threat to the treatment outcome.

In this article, we are describing for the first time a classical S-GBR protocol we have been using in daily practice for 6 years, were the screws are associated with a bone xenograft, a collagen membrane, some allograft and L-PRF membranes.

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2. Materials/methods and results

In 2007, this 67 years old woman came to the implant consultation. Her mandibular right second premolar and 3 molars were absent and all extracted more than 6 years ago. The patient was wearing a partial denture since 6 years and was expecting a fixed prosthetic rehabilitation of this area. We observed a strong resorption of the alveolar ridge, with a significant piece of free gingiva on the top of the slim residual alveolar crest **(Figures 1A, 1B)**. This patient was in good health and a moderate smoker (5 cigarettes per day). The remaining right first premolar was moving with a terminal mobility.

During the first surgery, we started by extracting the mobile first premolar and the residual alveolus was carefully cleaned using hand instruments and round bur. The residual alveolar bone crest appeared very resorbed and slim **(Figure 1C)**. In order to place implants in an adequate functional and esthetic position, the bone ridge should be regenerated both in width and in height.

As a first step to prepare the bone regenerative compartment, we drilled 10 holes in the cortical buccal wall of the residual crest, in order to provoke light bleeding following the endosseous stimulation principles. Five osteosynthesis screws (1.5mm in diameter, 8mm long, special kit for implantology, Synthes GmbH, Zuchwil, Switzerland) were then placed on the same buccal wall, to serve as tent pegs and space maintainers for the bone regenerative compartment and as supporting pillars for the grafted material **(Figure 1D)**. The position of the screws was important, as the position of the head of the screws would define the future position of the regenerated alveolar ridge and the space available for the implant positioning. In this case, we wished bone regeneration in width and in height following the expected occlusal line of the future prosthetic rehabilitation; therefore the osteosynthesis screws were placed in line with a 45 degrees from the expected horizontal occlusal face of the regenerated bone ridge. The position line was thought to support the bone grafting material and the bone growth in lateral and vertical position, and to build up the buccal/occlusal corner of the regenerated bone ridge at least up to the level of the initial residual crest.

In this technique, the choice of the bone material and of the GBR barrier membrane was very important and their combination was a critical parameter. In this case, we decided to combine a naturally cross-linked collagen membrane with a relatively short resorption time of 8 to 12 weeks (now marketed as BoneProtect Guide, Dentegris GmbH, Duisburg, Germany). This medium-term barrier was placed in position first **(Figure 1E)**. Then the bone regenerative compartment between the osteosynthesis screws was filled with a special mixed bone material prepared with half of allogeneic bone material (Tutoplast Spongiosa, Tutogen Medical GmbH, Neunkirchen am Brand, Germany) and half of a bovine bone substitute (now marketed as CompactBone B, Dentegris GmbH, Duisburg, Germany) using a granulation of 0.5 to 1mm diameter per bone particle **(Figure 1F)**. Finally, the regenerative chamber and bone materials were covered with 4 layers of L-PRF membranes (marketed as Intra-Spin system and the Xpression preparation kit, Intra-Lock, Boca-Raton, FL, USA)**(Figure 1G)**, and the collagen membrane was repositioned over the site. Periosteal incisions were performed on the flaps in order to promote a tension-free closure of the flaps. The surgical site was sutured with non-resorbable sutures (silk 4.0, Hu-Friedy, Chicago, IL, USA)**(Figure 2A)**. Sutures were removed after 6 days. The post-surgical follow-up was uneventful.

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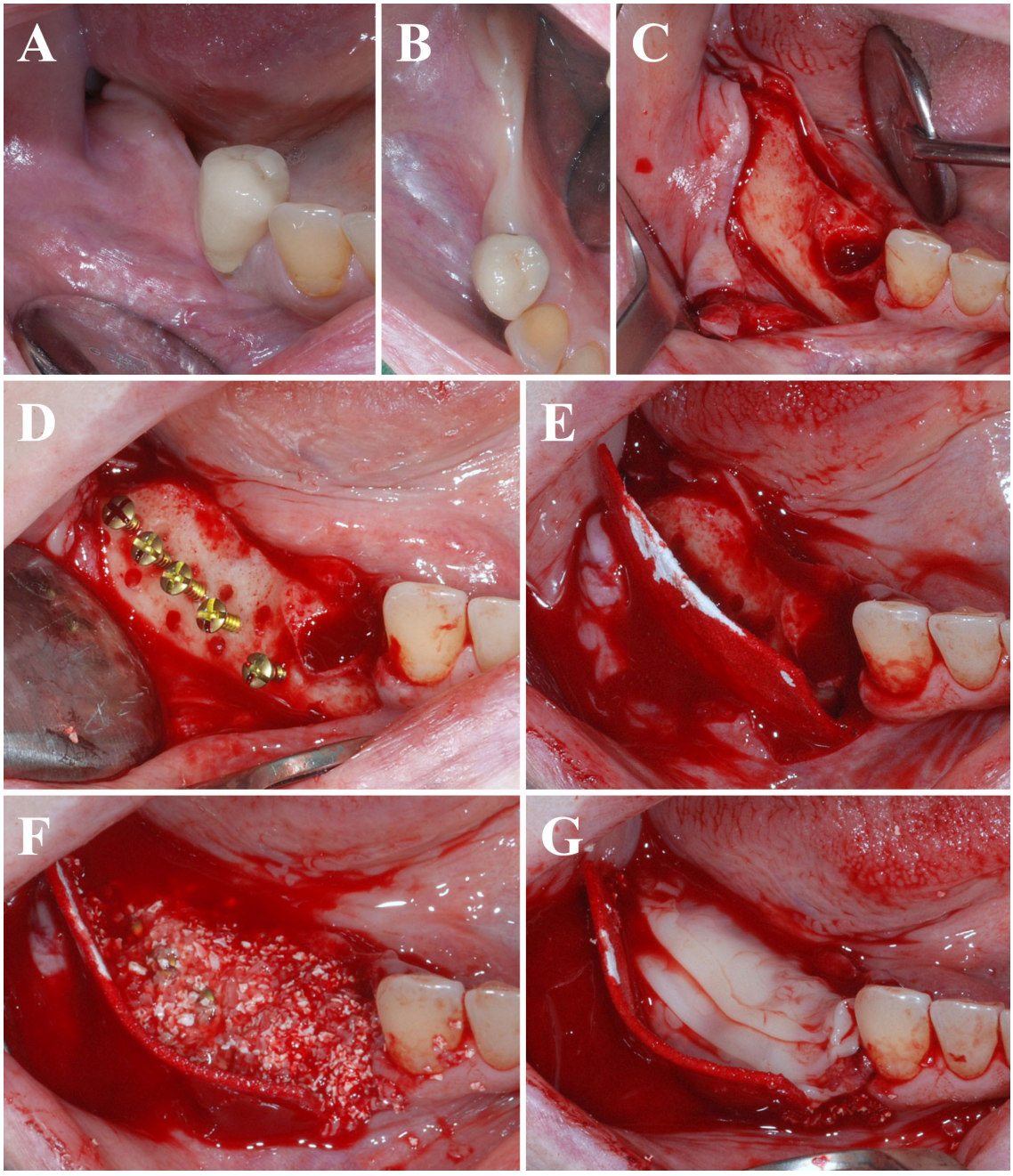

Figure 1. S-GBR surgery in the severely resorbed posterior mandible. (A, B) Initial situation. We observed a thin crest with a free piece of gingiva on the top. **(C)** The surgical site was opened revealing a severely resorbed residual ridge, and the residual mobile premolar was extracted. The alveolus was carefully curetted. **(D)** Ten holes of endosseous stimulation were done to prepare the bone compartment. Five osteosynthesis screws were placed in line in adequate position, with a 45 degrees angle from the expected occlusal plan. **(E)** A collagen membrane was placed to delimit the future bone regeneration compartment. **(F)** The space between and above the screws was filled with a mixed bone material (50% bovine xenograft, 50% allograft). **(G)** The regeneration compartment was covered with 4 layers of L-PRF membranes, and the collagen membrane was then replaced on it.

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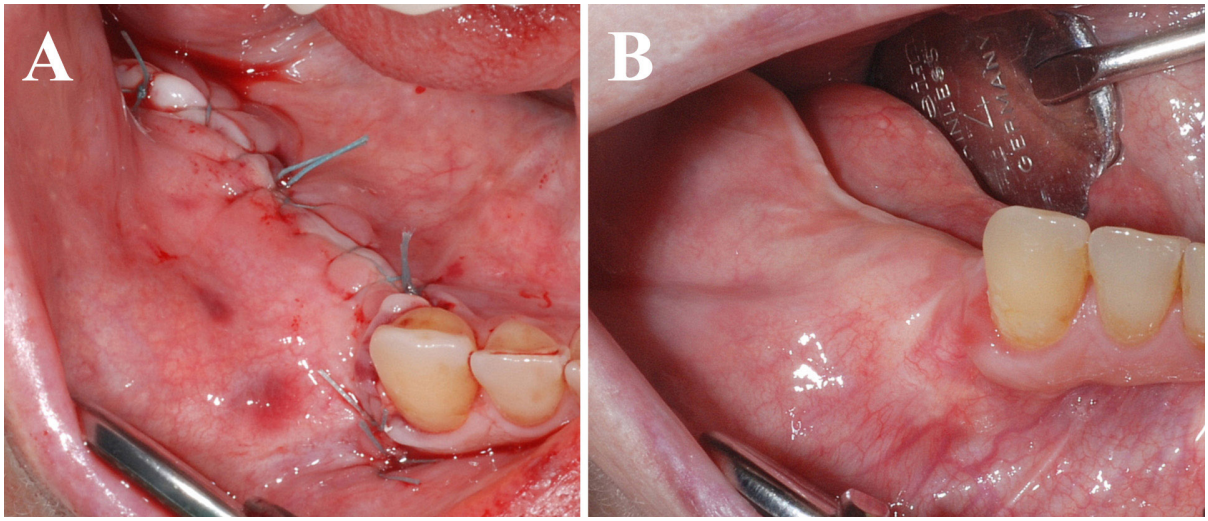

Figure 2. Follow-up of the S-GBR surgery in the severely resorbed posterior mandible. (A) Sutures were done tension-free thanks to periosteal incisions on the flaps. **(B)** Four months after the surgery, the gingival tissue was healed, keratinized and adherent on a wide regenerated alveolar ridge.

Four months after the initial regeneration surgery, the gingival tissue appeared healed and mature **(Figure 2B)**. The regenerated alveolar crest had a very different aspect and appeared wide and strong, and the radiographic follow-up did not show any anomaly.

During the second surgical step, the flaps were raised again to reenter the site. The bone aspect was a bit irregular on the external layer, lightly bleeding and compact with a D2-D3 density **(Figure 3A)**. The heads of the osteosynthesis screws appeared clearly. The 5 screws were removed carefully, and light bleeding could be observed from the holes **(Figure 3B)**. Two implant osteotomies were performed in this dense bone and the holes were both bleeding and apparently homogeneous **(Figure 3C)**. Two implants were then placed (Xive, Dentsply Implants, Mannheim, Germany), respectively 3.8mm x 11mm and 4.5mm x 11mm **(Figure 3D)**. Some autologous bone from the implant osteotomy drilling was collected and added around the collars of the implants to reinforce this important area. The whole regenerated area was covered with a final layer of bovine bone substitute (now marketed as CompactBone B, Dentegris GmbH, Duisburg, Germany), in order to increase and stabilize the regenerated bone volume **(Figure 3E)**. Finally, the whole area was covered with 4 layers of L-PRF membranes (marketed as Intra-Spin system and the Xpression preparation kit, Intra-Lock, Boca-Raton, FL, USA)**(Figure 3F)**, in order to maintain the supplementary grafting material and to promote the healing and maturation of the gingival tissue.

Three months after this second surgery, the trans-gingival healing screws were connected. After healing, the prosthetic abutments were placed **(Figure 4A)** and the final prosthesis was added 2 weeks later. The total time to do this rehabilitation was therefore around 8 months. The clinical and radiographic follow-up was done each 6 months during the first 2 years and then each year. Five years after treatment, the rehabilitation appeared stable and no bone loss was noticed **(Figure 4B)**.

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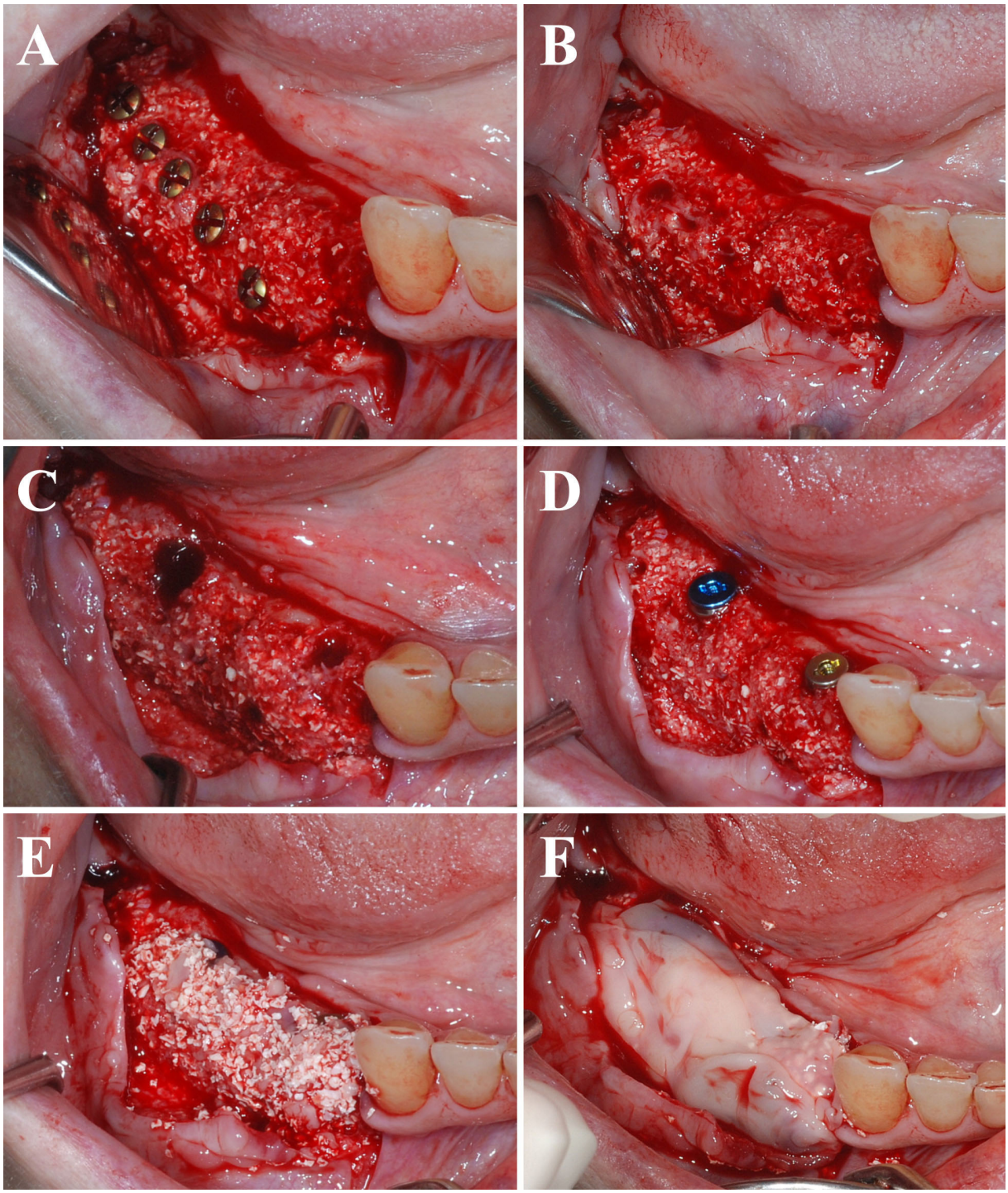

Figure 3. Implantation phase, four months after S-GBR surgery in the severely resorbed posterior mandible. (A) Four months after S-GBR, the surgical site was reopened, revealing a dense, lightly bleeding and irregular external aspect of the regenerated volumes around the screws. **(B)** Screws were removed, and a light bleeding appeared from the holes. **(C)** Implant osteotomies were done. **(D)** Two implants were placed. **(E)** Autologous bone from drilling was placed around the implant collars and then covered with a supplementary layer of bovine xenograft bone material. **(F)** Four layers of L-PRF membranes were placed all over the surgical site, to maintain the grafted material and to stimulate soft tissue healing and maturation. Then the site was sutured tension-free.

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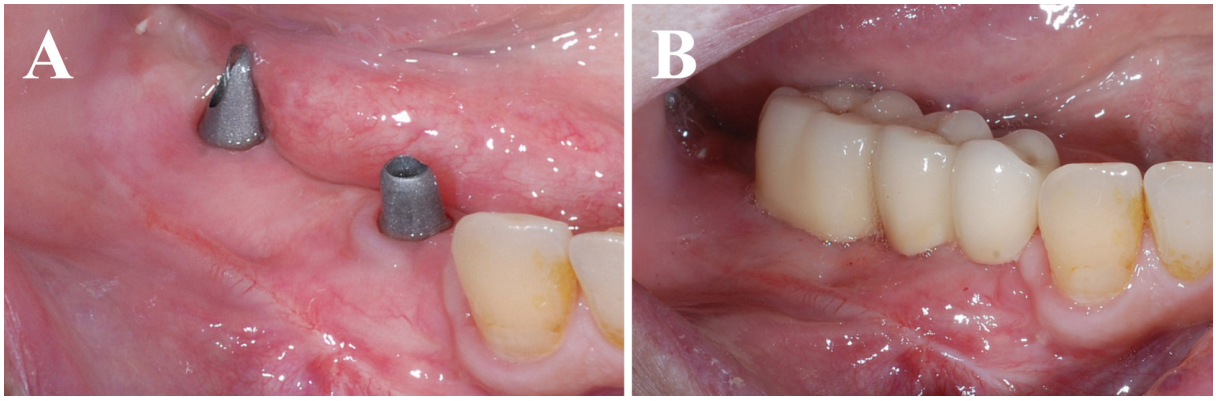

Figure 4. Prosthetic phase and follow-up. (A) Three months after implantation, trans-gingival screws were placed, and abutments were connected 2 weeks later **(B)** Five years after the end of treatment, the rehabilitation appeared stable and no bone loss was noticed in the radiographic and clinical follow-up.

3. Discussion

This case is a description of a traditional approach to S-GBR. The use of screws is not very difficult in theory and the bone regeneration appeared to be stable, but the way to prepare the regeneration chamber must be handle with care, particularly the endosseous stimulation, the position of the screws and the flap closure. However, the real question always remains what kind of materials and membranes to associate – and how to associate them – to get the best clinical results.

In the early phase of this technique, as described in the part 1 of this article series, we were mostly using xenograft. This material was mostly mineral with a very slow remodeling time and weak integration **[13]**, what required to combine it with a collagen resorbable membrane and a Teflon non-resorbable membrane. In our experience, this strategy worked well, but longer healing times were needed to have a regenerated bone for proper implantation (7 months for regeneration).

In the case described in this article, the procedure was simplified thanks to a better selection of materials. The bone grafting material was a mix of allograft and xenograft: the allograft integrated quicker on the surgical site, while the xenograft was more stable on the long-term **[14]**. No non-resorbable membrane was needed. We still used a collagen membrane because of the presence of the mineral xenograft material **[13]**. We used L-PRF membranes everywhere to improve bone integration, gingival healing and maturation and to secure the surgical site **[7,8]**. The exact properties of the L-PRF membranes as GBR barrier are debated **[15]** and largely dependent on the way it is used, but this material anyway offers a great opportunity to improve soft tissue healing and to avoid gingival dehiscence above the bone regeneration chambers **[7,8]**. With this method the surgery was easier and the required time for bone regeneration did not exceed 4 months. More important, the bone regeneration appeared more homogeneous clinically, even if we are lacking proper scientific evaluation.

As a conclusion, in our experience, the S-GBR strategy is an efficient approach for the treatment of the severely resorbed mandible. L-PRF appeared to be a strong element of surgical simplification, reduction of gingival dehiscence risks and improvement of soft tissue

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maturation. The choice of the adequate combination of bone materials and barriers remains debatable, and requires further scientific evaluation on large series.

Disclosure of interests

The authors have no conflict of interest to report.

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