

Clinical case letter

Preimplant reconstruction of the severely resorbed posterior mandible using the Sandwich technique with piezosurgical osteotomy and Leukocyte- and Platelet-Rich Fibrin (L-PRF): a 5-year follow-up with histological controls

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1. Introduction

The implant-supported treatment of the resorbed posterior mandible is often difficult due to the significant centrifuge resorption of the mandible alveolar ridge after extraction and the proximity of the large nervous-vascular pedicle in the mandibular canal within the mandible body. The residual alveolar ridges can have many different shapes and volumes, and the position of implants is often a challenge. To reconstruct the bone volume prior to implant placement, many techniques have been proposed, but no real consensus exists on what would be the ideal solution or combination of treatments. The use of bone grafting remains a difficult approach that requires experience and skilled clinicians, as the strong cortical bone of the mandible body does not integrate easily bone substitutes or even autologous bone grafts. The risk of partial or complete failure remains significant in the treatment of this area.

In order to bypass the risk of rejection of the bone graft from the cortical bone layer, several techniques were proposed to promote the bone regeneration by splitting the mandibular residual bone ridge and separating a mobile segment to create a medullar space. In this space, bone can be grafted or space can be maintained alone (with a natural blood clot) to regenerate the chamber. Many forms of these techniques exist, such as lateral expansions (where the space is maintained by the dental implants)[1,2] or distraction osteogenesis [3,4].

A concept of “sandwich” technique was proposed already a long time ago [5], and many authors suggested various forms of evolution [6,7]. In this technique, a cortical bone segment is split and maintained in higher position through the use of screws and plates. The space between the mandible body and the fragments is then filled with some autologous bone or bone biomaterials.

Like for all bone grafting techniques, particularly in the posterior mandible, important issues of this technique are the risk of mechanical and biological constraints on the surgical area and the risk of gingival dehiscence above the grafted area. The gingiva is the only protection against the contamination of the bone regenerative compartment. Moreover, this surgery is very delicate and the use of adequate instruments and procedure is very much necessary to avoid strong inflammatory reactions and bone resorption. The addition of platelet concentrates for surgical use [8], particularly of L-PRF, was already advocated as a

healing and interposition material in several clinical situations [4], in order to simplify surgical procedures and improve bone and soft tissue healing [9,10].

In this article, we describe a modified version of the sandwich technique, using piezosurgical instruments for non-traumatic osteotomy and L-PRF (Leukocyte- and Platelet-Rich Fibrin) as regenerative and protection material for bone and gingival tissues of the expanded area.

2. Materials/methods and results

The patient was a 53-year old woman, in good general conditions and non-smoker, looking for the rehabilitation of her lower left region. The computed tomography CT-Scanner radiographs revealed a significant resorption of the alveolar bone with a limited bone height (5-6mm) above the mandibular nerve and a deformed curved shape of the residual bone (**Figures 1, 2A**). Several practitioners already considered the alveolar crest was not suitable for implantation. A treatment plan including a “sandwich” technique was proposed, in order to gain vertical height and to obtain a more homogeneous horizontal shape of the alveolar ridge.

The clinical procedure was performed using local anesthesia and conscious sedation. L-PRF was prepared using the standard protocol and material (marketed in a FDA approved/CE marked kit as Intra-Spin L-PRF, 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 to be used at the end of the surgery.

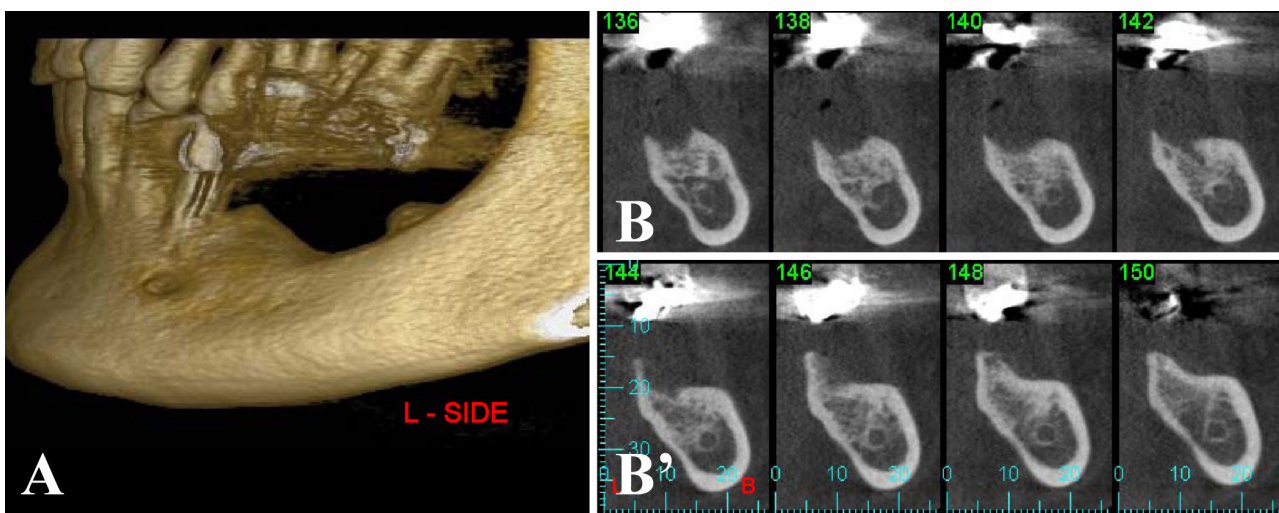


Figure 1. Presurgical CT scanner examination. (A) The residual alveolar ridge was significantly resorbed in height but offered significant volumes in width. (B, B') The residual bone height was around 5-6mm and the mandible body shape was not suitable for adequate direct implantation.

A full muco-periosteal flap was raised in order to have a clear access to the cortical bone body of the mandible. Two vertical and one horizontal deep cuts were made using the piezosurgical lancet (Piezosurgery, Mectron s.p.a., Carasco, Italy) on the buccal wall of the alveolar ridge (**Figure 2B**). Care was taken to keep the lingual part of the muco-gingival flap attached to the cut bone fragment, in order to maintain a natural blood supply to the mobile bone fragment. The bone segment was raised using a chisel to obtain a rotational elevation up to 7mm (**Figures 2C, 2D**). The segment was finally stabilized with bone fixating osteosynthesis plates and screws (Biomet 3I, Palm Beach Gardens, FL, USA), leaving a regenerative chamber between the mandible body and the repositioned segment (**Figure 2E**). Holes for endosseous stimulation were performed with a surgical bur on the mandible body along the regenerative chamber, in order to promote bleeding, cell migration and tissue integration (**Figure 2E**). An osteoinductive allograft material (Regenaform, Exactech Inc, Gainesville, USA) was then prepared by mixing with L-PRF clots (2 membranes cut in small pieces) following a ratio of 1/3 L-PRF, 2/3 material. The material was then packed within the regenerative chamber and around the segment, in order to regenerate a homogeneous alveolar ridge (**Figure 2F**). Six L-PRF membranes were then used to cover and protect the surgical site (**Figure 2G**). The flap was prepared with periosteal incisions in order to cover the surgical area properly and sutured using 3/0 vicryl sutures (**Figure 2H**). Post-surgical follow-up was uneventful, no mandibular nerve paresthesia was noticed and sutures were removed after 8 days.

Five months later, the gingival tissue appeared mature on a wide alveolar ridge (**Figure 3A**). CT scanner was done and revealed a homogeneous bone volume after bone regeneration of the crest (**Figure 3B**). The surgical site was reopened to remove the osteosynthesis plates and screws (**Figure 3C**), and 4 bone biopsies were collected with a trephine in the expected places of the implants. Finally, the 4 implant osteotomies were finished with the adequate drill (**Figure 3D**) and 4 internal connection implants were placed (Biomet 3I, Palm Beach Gardens, FL, USA), all 4mm in diameter and respectively 13mm, 11.5mm, 10mm and 10mm from mesial to distal. Three months later, the trans-gingival screws were placed. After healing, an implant-supported bridge was performed (**Figures 3E, 3F**). The follow-up was organized each 6 months the first 2 years, and then each year.

The four bone biopsies were fixed in 10 % buffered formalin, dehydrated in alcohol, embedded in resin and cut following the Exakt non-decalcified protocol for cutting-grinding histology (Exakt, Norderstedt, Germany). Each cut was grinded down to 40 µm and stained with Van Gieson's picro-fuchsin. On these histology sections, no infection or inflammatory reactions were observed. Most of the sample was organized with a medullar viable bone (**Figure 4A**), covered with compact cortical vital bone at the top of the sample (**Figure 4B**).

The last control after 5 years (**Figure 4C**) showed very stable alveolar bone ridge volume and peri-implant bone and soft tissues.

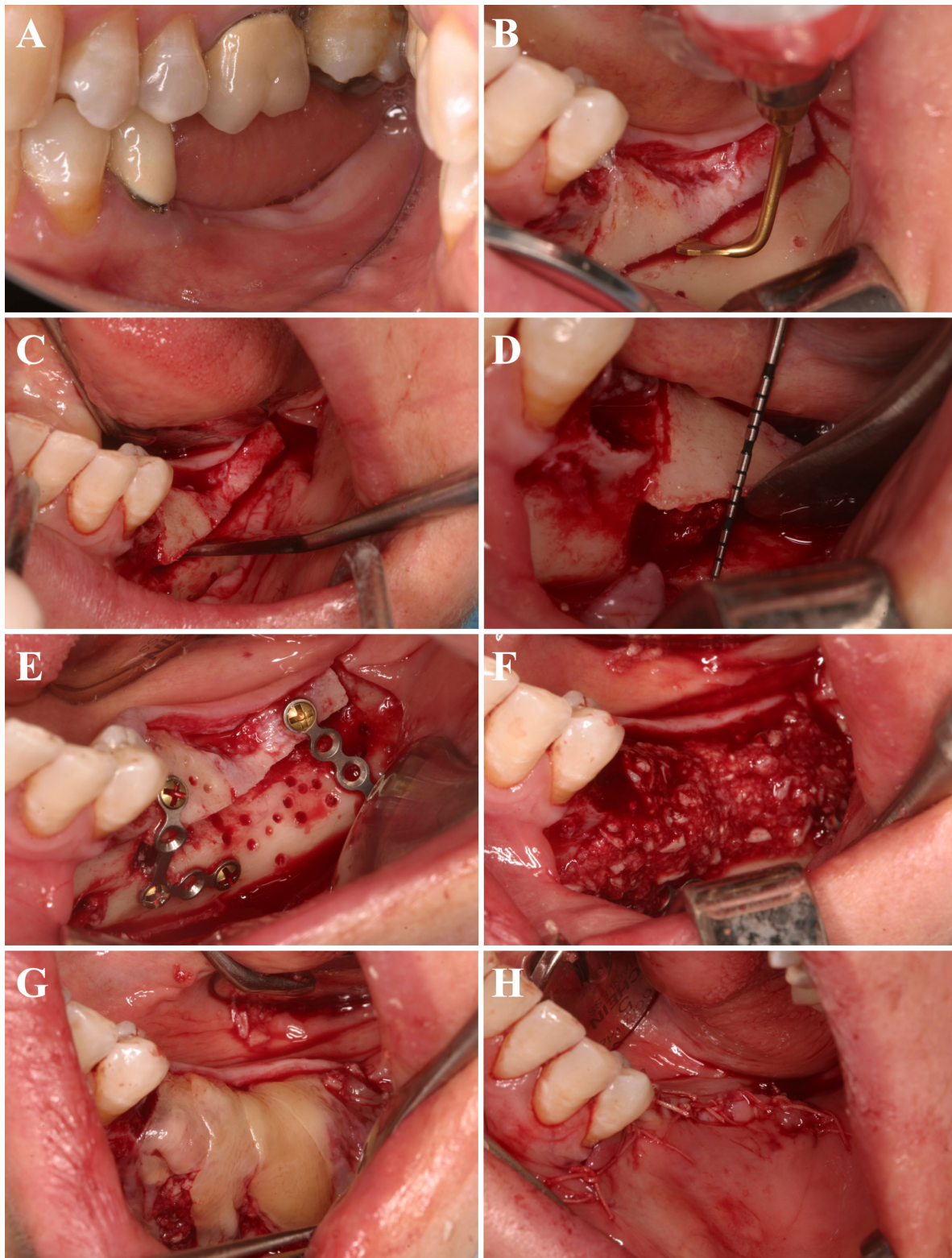


Figure 2. The bone reconstruction surgical phase. (A) The prosthetic space between the maxillary teeth and the mandibular ridge was very high due to the significant mandibular bone resorption. (B) Three deep incisions were performed with a piezosurgical lancet to split a large bone segment. (C) The segment was separated and lifted with a chisel. (D) The fragment was stabilized around 7mm high with a movement of rotation. (E) The bone segment was then stabilized with 2 osteosynthesis plates and screws, and the cortical site was activated through endosseous stimulation holes. (F) The area was grafted with a mix of bone substitute with L-PRF clot. (G) The whole site was then covered and protected with 6 L-PRF membranes. (H) The site was sutured.

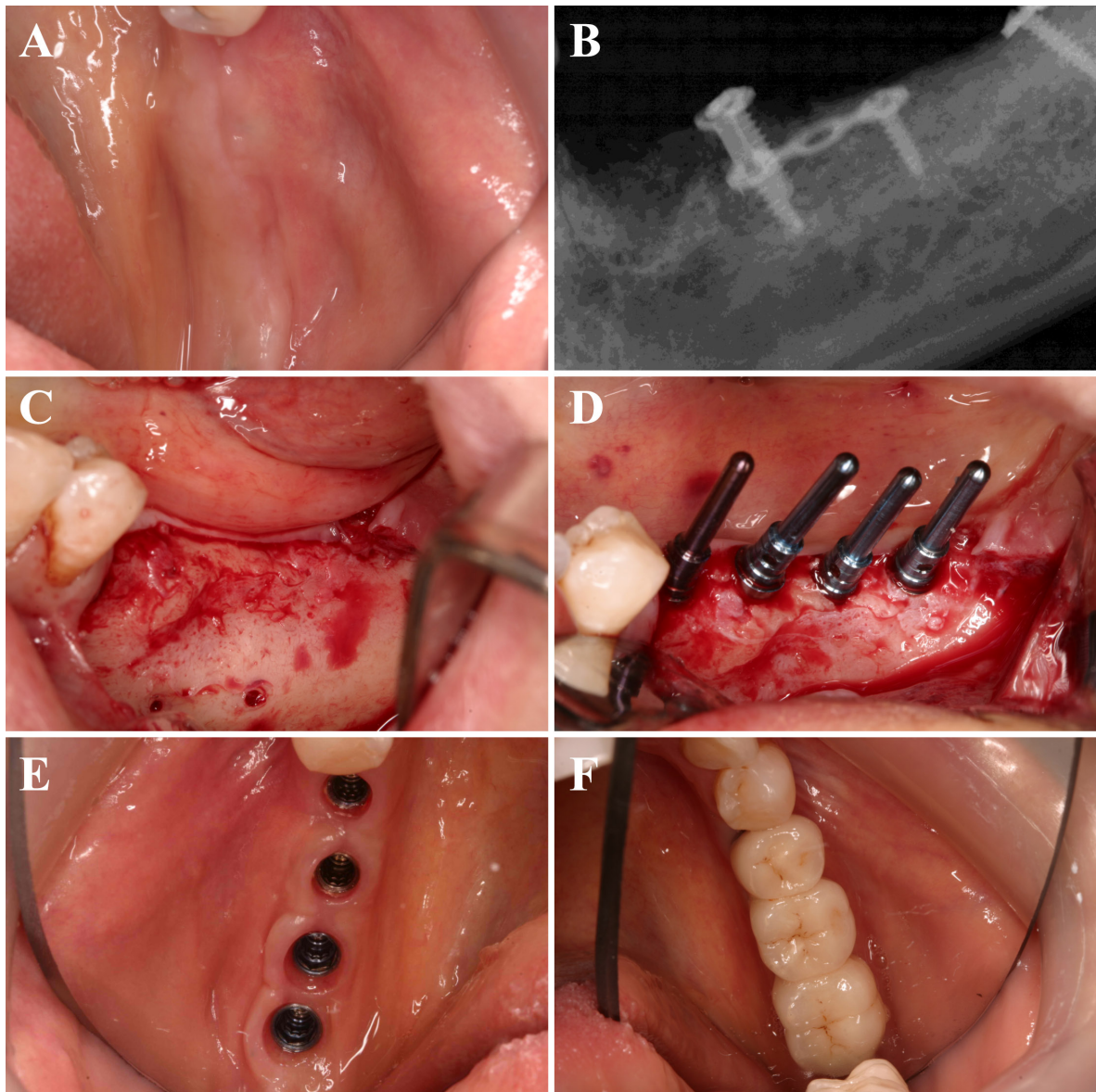


Figure 3. The implant phase. (A) Five months after the bone surgery, the gingival tissue was healed and matured. (B) Radiographic follow-up confirmed the proper regeneration of the bone volume. (C) Osteosynthesis plates and screws were removed, and the regenerated alveolar ridge appeared homogeneous and well shaped. (D) The regenerated bone volume allowed to perform the implant osteotomies in ideal positioning. Implants were then placed. (E) Three months after implantation, the trans-gingival screws were placed. After healing, a strong and mature peri-implant gingival tissue could be observed around all implants. (F) An implant-supported bridge was finally placed.

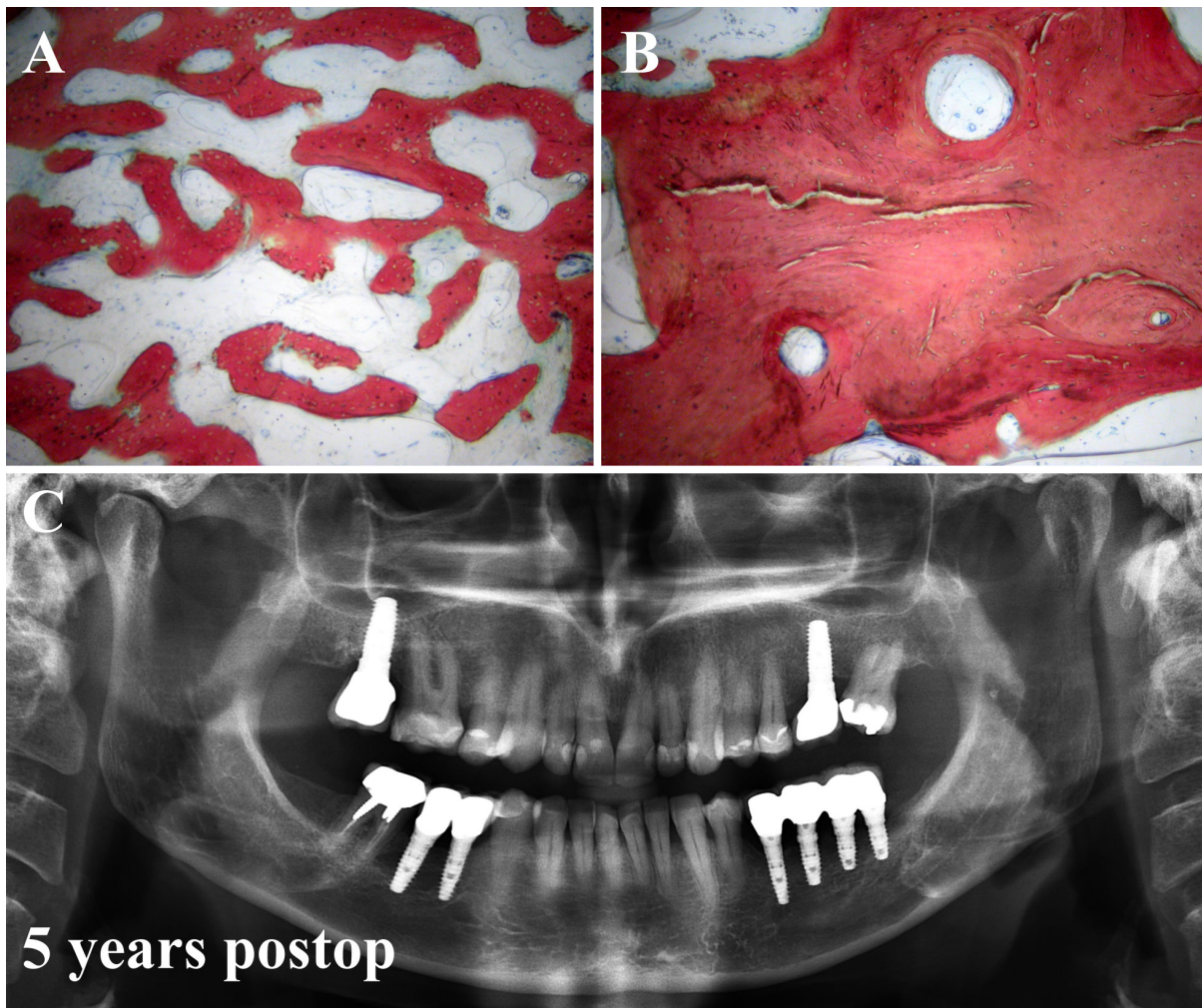


Figure 4. Histological findings and follow-up. (A) Histological analysis of the bone biopsies showed a vital medullar bone in most of the sample of regenerated ridge. **(B)** The top of the sample was also made of some strong cortical layer. **(C)** The 5-year clinical and radiological follow-up revealed a stable implant-supported rehabilitation with no visible peri-implant bone loss.

3. Discussion

The development of various forms of osteotomies and expansions is already an old and well-documented approach in modern implant dentistry [1,3,6,7]. This concept is interesting as direct grafts are always difficult to integrate on the very cortical bone of the posterior mandible. However, even if the expansions techniques are well known, their use in daily practice remains limited to a relatively small number of surgeons, as the success of these therapeutic strategies remains very dependent on the skills and experience of the practitioners.

In order to improve the feasibility of these techniques, the use of various surgical adjuvants and improved surgical instruments should be considered with care and interest. The piezosurgical lancet was already advocated as an adequate non-traumatic instrument for the splitting of alveolar ridges in the various kinds of expansions and distraction osteogenesis techniques [2]. The cut power of the instrument is lower than a traditional surgical bur, but

the cut is safer, less traumatic and finally more accurate [11]. More important, the ultrasonic vibrations of the instruments are very helpful to split solid pieces, what makes the final split of the bone fragments much easier [12]. This instrument can be considered as a gold standard for this kind of surgery.

The use of L-PRF as regenerative and interposition material in this kind of surgery has never been published before. L-PRF is a platelet concentrate for surgical use, prepared by centrifugation of a blood sample [8]. The final clot or membrane contains most of the platelets and half of the leukocytes of the initial blood sample [13]. This membrane releases growth factors during at least 7 days [14] and has a strong proliferation and differentiation effect on bone and gingival cells [15]. In this application, the L-PRF is used to help the vascularization and bone regeneration of the grafted bone volume, but its main function is the protection of the regenerative chamber [10]. The L-PRF layers stimulate the healing and maturation of the gingival tissue and avoid the risk of soft tissue dehiscence around the grafted material [9]. Moreover, a strong gingival maturation is always noticed in the area covered with many layers of L-PRF, and this was also observed in this case, particularly for the peri-implant papilla [9,10].

As a conclusion, the use of L-PRF as surgical adjuvant and piezosurgical devices offers new opportunities to make this surgery safer and more predictable. It remains a difficult surgery that requires adequate technical skills and experience, but the reduction of bone stress and improvement of healing through the use of these materials clearly make it more accessible.

Disclosure of interests

The authors have no conflict of interest to report.

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