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Case report

VERTICAL AND HORIZONTAL GBR VIA A DEMINERALIZED XENOGENIC BONE CORTICAL LAMINA: A CASE REPORT

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ABSTRACT

Vertical and horizontal bone defect is a challenge in oral surgery. Alveolar bone reconstruction is needed before implant insertion. Several surgical techniques are available. Here a case of posterior alveolar ridge reconstruction is reported together with a histological evaluation of bone sampled after 6 months of healing. Histological results suggest the validity of surgical procedures for bone volume regeneration in the distal mandibular region. Furthermore, according to our clinical experience, both the pre-hydration and stabilization of the device, with fixation screws, are strongly recommended if vertical bone regeneration is needed.

KEYWORDS: *bone, regeneration, mandible, lamina, crest, reconstruction*

INTRODUCTION

It is known that GBR is carried out through a barrier device, also named membrane, which maintains a volumetrically stable space in the area to be regenerated, preventing the soft tissues from colonizing it for the entire period necessary for regeneration (1). Barrier devices can be resorbable or non-absorbable; the latter is made of PTFE, generally reinforced with a titanium framework, or can be made of a titanium sheet only (1). Non-resorbable barriers must be removed during second-stage surgery and are indicated in the case of vertical or combined vertical and horizontal bone regenerations (1, 2).

On the other hand, the resorbable membranes, being degraded by the host, do not require any removal and are indicated exclusively for horizontal bone regeneration due to their limited ability to maintain a stable volume over time in the area to be regenerated (3). Resorbable membranes are a merchandise-heterogeneous family of devices that differ both in the materials used (i.e., bio-polymers; collagen) and how these materials are processed (i.e., cross-linking of collagen) to maintain their persistence in the organism and action of colonization inhibition, by the soft tissues, for all the time required for bone regeneration (4).

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Here, a case of posterior alveolar ridge reconstruction is reported together with a histological evaluation of bone sampled after 6 months of healing.

MATERIALS AND METHODS

A 44-year-old nonsmoker came to our clinic because she was concerned about lower jaw edentulness. She had no previous pathologies, and neither had she taken pills.

The absence of molars and atrophy of the posterior right mandible was seen at the clinical evaluation. Alveolar crestal reduction was vertical and broad. Impression was taken to plan the correct position of prosthetic restoration, and then a radiological Dima with guttapercha references was produced. The patient did a panorex X-ray and a CBCT; in this latter the patient wore the Dima. CBCT showed vertical and width atrophy (Fig. 1). Thus, it was proposed to perform a bone regeneration to insert an implant in a second stage. The patient agreed and signed informed consent.

First-stage surgical procedure

Antimicrobial prophylaxis was administered with amoxicillin-clavulanate (Clavulin, Glaxo- SmithKline, Italy), 1 g every 8 h for 7 days, starting 3 h before the operation, after an initial 1 min rinse with chlorhexidine digluconate 0.2% (Corsodyl Mouthwash, GlaxoSmithKline, Italy) to disinfect the mouth. In the surgical area, loco-regional anaesthesia was performed with articaine hydrochloride 4% with epinephrine 1:100,000 (Citocartin, Molteni Dental, Italy).

Then a crestal full-thickness incision was performed in the edentulous area with a No. 15 surgical blade to split keratinized tissue equally.

On the buccal side, the incision was intrasulcular extended to the adjacent premolars and canine without a vertical release incision while posteriorly the incision ended with a vestibular oblique incision (45°) at the level of the occlusal

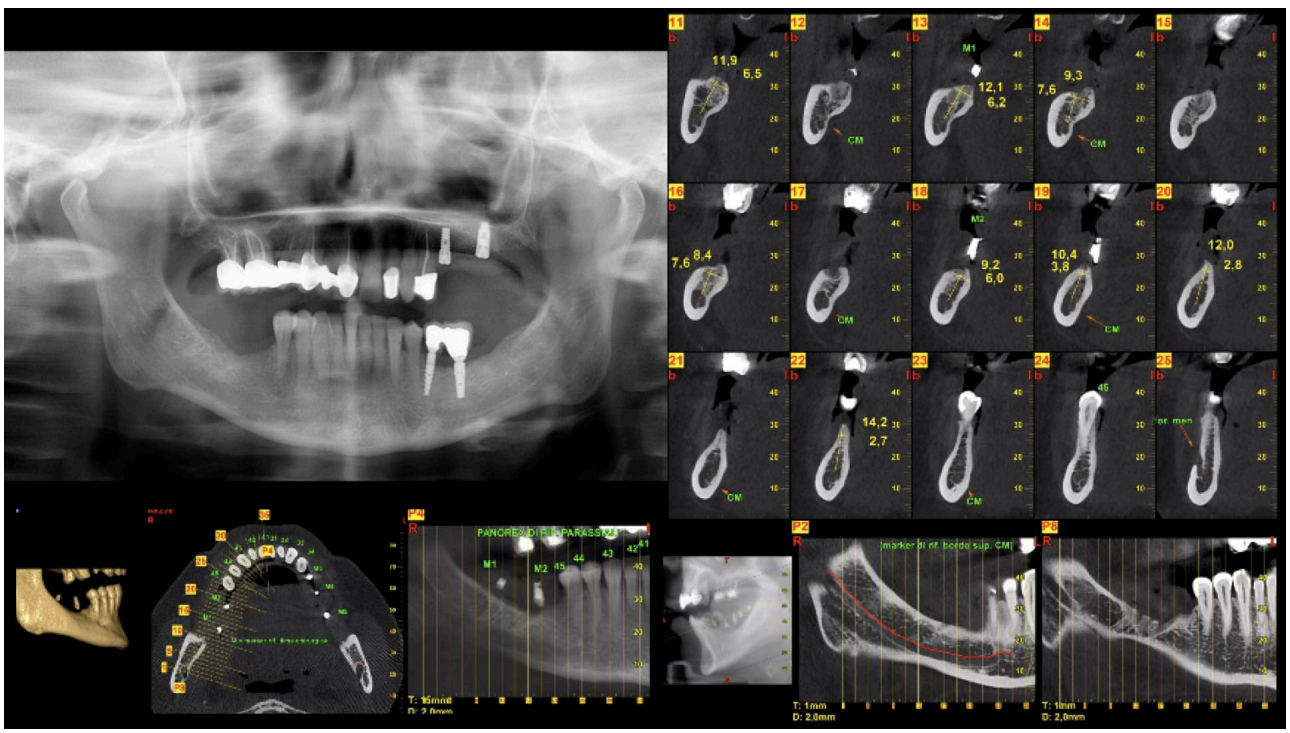

Fig. 1. *Pre-surgical RX, panorex and CBCT.*

plane. Lingually, to obtain an adequate length of the flap, a marginal incision was extended mesial to the adjacent premolars, avoiding vertical incisions (Fig. 2A, 2B).

To obtain passivation of the lingual flap, in the middle area, the superficial fibers of the mylohyoid muscle were carefully detached, by a periodontal probe (5). In the distal area, the adherent tissues, of the retro-molar pad, were full-thickness lifted by the use of a Prichard elevator (6). On the vestibular site, at the level of premolars, the flap was carefully full-thickness raised, to locate the mental foramen area and the neurovascular bundle. Then a shallow periosteum incision was made, from the distal to the medial portion of the buccal flap, by using a new No. 15 blade, then the inner surface of the flap was carefully "brushed", until the desired elongation was achieved (7).

The collection of autologous bone was performed principally from the homolateral ramus of the mandible and secondary from the recipient site by using a scraper (Safescraper® TWIST, META, Reggio Emilia, Italy). The bone scraping procedure was considered sufficient to activate the regional acceleratory phenomenon, at the recipient site (8) (Fig. 2B).

The device (Curved Soft Lamina, 1.0 mm: 35x35 mm, OsteoBiol, Tecnoss, Turin, Italy) was previously hydrated with sterile saline solution (Fig. 2C), then the device has been molded with a pair of curved surgical scissors. Once achieved the desired shape the device has been fixed on the vestibular site by means a Bone Fixation Screw (VM-01-003; FMD Dental, Rome, Italy) coupled with a titanium rondel so as to prevent the undesired laceration of the device, during the screwing procedure (Fig. 2E).

The autologous bone was then layered on the recipient site (Fig. 2F) followed by the placement of a layer of collagenated porcine xenograft (MP3, A3005FS, 1.0 cc, OsteoBiol, Tecnoss, Turin, Italy) (Fig. 2G). The device has been then reflected, over the graft and fixed, as previously described, on both the retro-molar area and the lingual side (Fig. 2H).

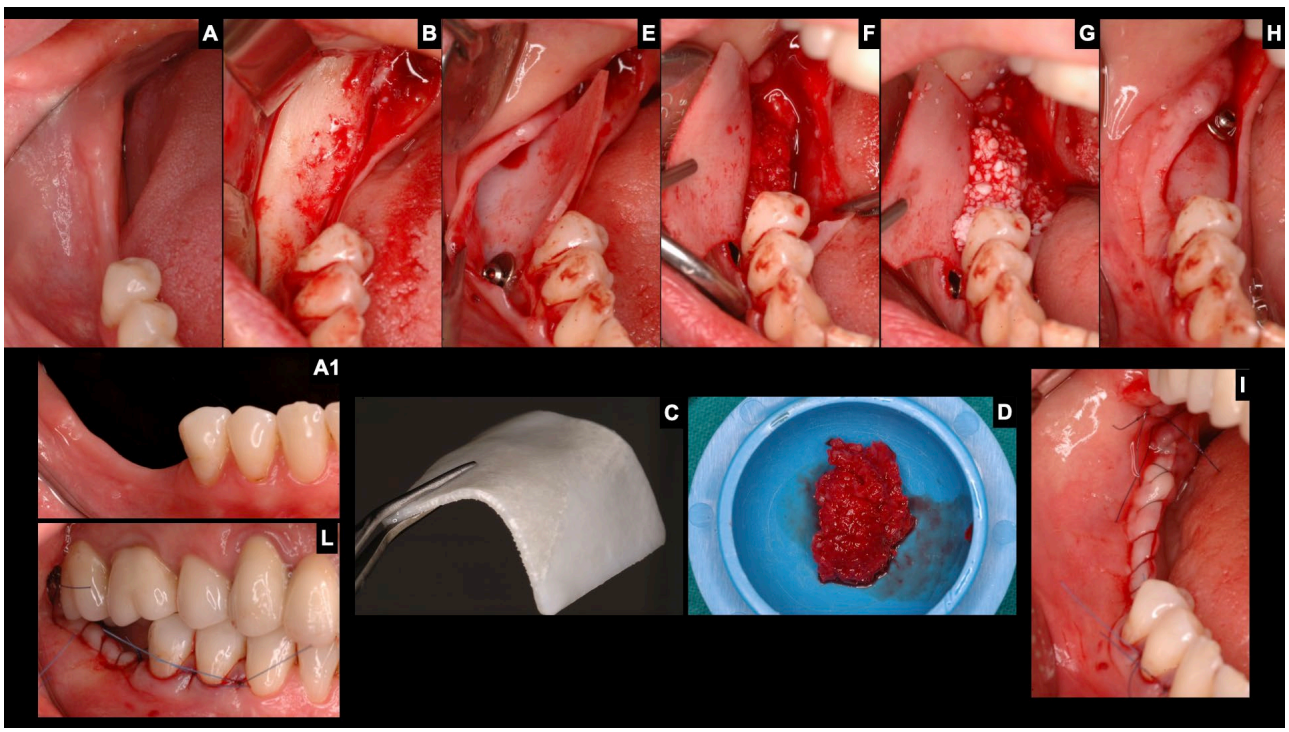

Fig. 2. ***A-A1)****: pre-surgical view;* ***B)****: muco-periosteal flap elevated;* ***C)****: cortical lamina is hydrated before modeling;* ***D)****: autologous bone is collected by means of a scraper from mandibular ramus;* ***E)****: lamina is fixed by means screws and titanium rondels; F: autologous bone is placed on mandible as first step;* ***G)****: then xenograft is placed on to the recipient site;* ***H)****: lamina is curved and fixed;* ***I-L)****: muco-periosteal flap is sutured.*

The free of tensions flap was thus sutured, with a double-layered continuous suture, by means of a 6-0 nylon wire, first deeper line was a continuous horizontal mattress, while the second line was a spiral continuous suture (Fig. 2I, 2L, 3).

The patient was discharged and oral hygiene and food instructions provided. Ibuprofen (Brufen 600 mg, Abbot, Italy), every 8-12 hours for 5 days was administered to control postoperative pain and edema. Rinses with chlorhexidine digluconate 0.2% (Corsodyl Mouthwash, GlaxoSmithKline, Italy) were prescribed for the disinfection of the surgical wound, 2/3 times/day for 7 days. After 14 days the sutures were removed and new oral hygiene instructions were provided. The post-operative was uneventful, with exception of swelling and hematoma.

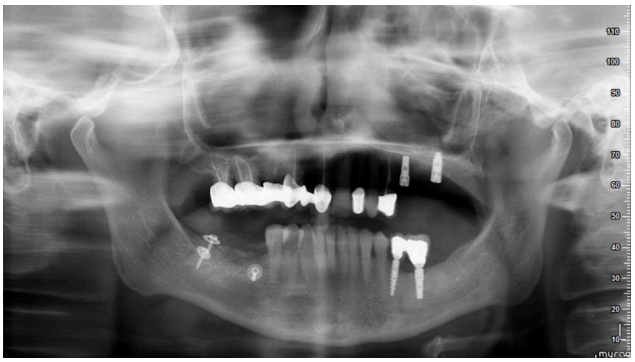

Fig. 3. *Post-operative panorex showing screws.*

Second-stage surgical procedure

After a suitable period, needed for the consolidation of the graft (6 months), the second stage surgery was performed. The re-entry (Fig. 4A, 4B) was executed with a full-thickness flap elevation approach, to remove the device, which had not been reabsorbed as expected (Fig. 4B, 4C). Prior to removing the coronal part of the device (Fig. 4D), by means of a No. 15 surgical blade, the fixation screws have been carefully pulled out. Then a two-piece cylindrical implant (I-Fix, FMD, Rome, Italy) was placed 2 mm under the free surface of the regenerated site. The implant site has been first prepared with a trephine drill (224RF, external diameter 2,7 mm, Hager & Meisinger GmbH, Neuss, Germany) so as to harvest a bone biopsy (Fig. 4E-L), then has been completed with dedicated cylindrical drills. Although the primary implant stability was greater than 50Ncm the fixture was placed submerged, in order to allow the periosteum-induced bone maturation (9). Thus, the flap was sutured, with the same continuous suture already described via a 4-0 silk wire (Fig. 4M, 5A). Drug prescriptions before and after surgery were identical to those of the first-stage surgery. The post-operative was limited to mild swelling, for 7 days.

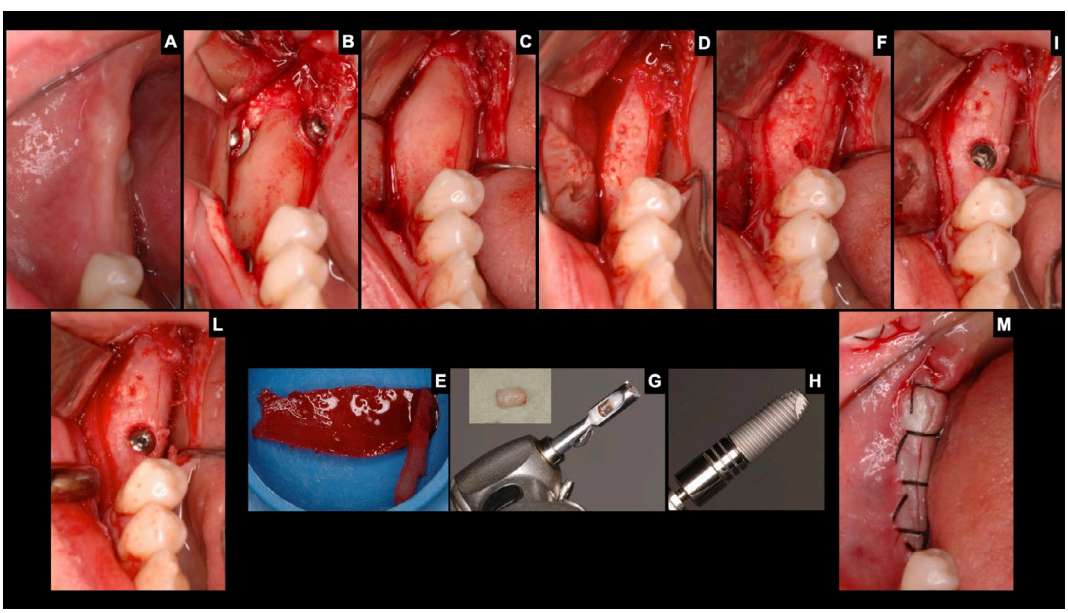

Fig. 4. **A**): *pre-surgical view before second stage surgery;* ***B****): a muco-periosteal flap is raised and lamina is visible;* ***C****): screws are removed;* ***D****): apical part of lamina is removed to find the underling regenerated bone;* ***E****): Fragment of removed lamina;* ***F****): initial implant tunnel preparation performed with a trephine drill to collect regenerated bone;* ***G****): trephine drill with biopsy;* ***H****): dental implant;* ***I****): implant insertion;* ***L****): implant connection is closed;* ***M****): muco-periosteal flap is sutured.*

Third-stage surgical procedure

After 4 months the implant was exposed with a full-thickness flap, dividing the band of keratinized gingiva into two halves, both the deepness of the fornix and the amount of keratinized gingiva were compliant with guidelines (10, 11) therefore additive soft tissue surgery was not needed. The flap was sutured with single sutures via a 4-0 silk wire. Drug prescriptions before and after surgery were identical to those of both first-stage and second-stage surgery. The post-operative was uneventful.

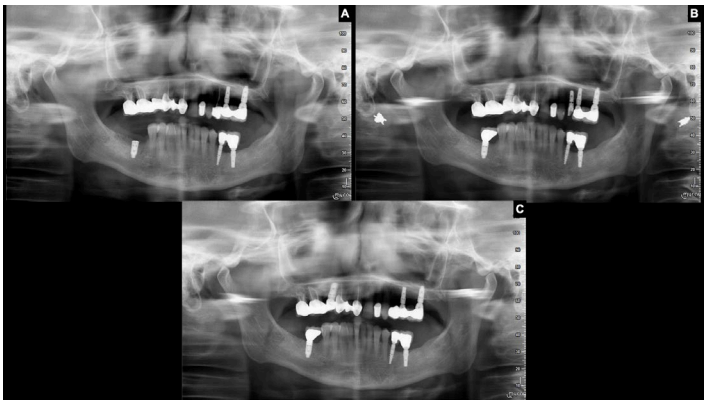

Fig. 5. RX – **A**): *when dental implant is inserted;* ***B****): after prosthetic placement;* ***C****): after 2 years from prosthetic placement.*

A month after surgery the case was finalized with a screw-retained metal-ceramic crown (Fig. 5B) and the hygiene instructions were delivered in the same stage. Follow-ups were performed at 3 and 6 months, so at 1 and 2 years (Fig. 5C), both the hard and soft tissues were healthy.

As in previous research (12, 13), the sample were fixed in 10% neutral buffered formalin and subsequently processed for analysis, by polarized transmitted light optical microscopy (Leitz Dialux, Germany). Thus, the sample was first demineralized, with a descaling solution containing EDTA (Kaltek, Padua, Italy), dehydrated on a scale of increasing alcohol content, embedded in paraffin and sectioned along its major axis, using a microtome (Leitz 1512, Germany). The sections, so performed, were then stained with hematoxylin-eosin.

RESULTS

From a clinical point of view, both the hard and soft tissues were healthy after 2 years follow-up. The histological examination, of the bone biopsy, shows in the upper portion a thick layer of connective (White Layer-WL). This soft tissue usually covers the regenerated bone and is considered a pseudo-periosteum (14). The WL wraps, in its lower portion, a wide area of amorphous material which is most likely represented by grafting material. Under the WL a spongy bone tissue, in various stages of remodeling, is found: there are areas of newly formed bone in which the cellular components are visibly active (Fig. 6A, 6B).

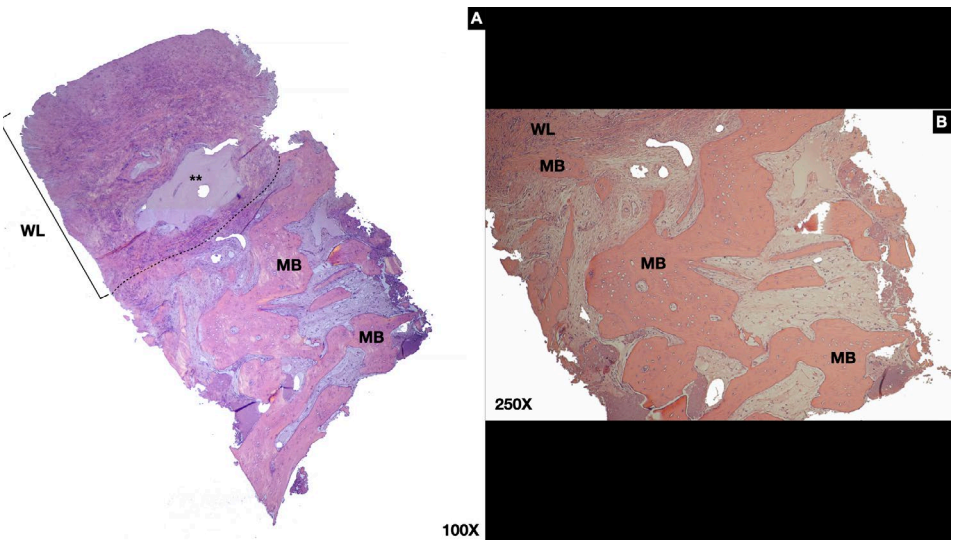

Fig. 6. *Histologic images.* ***A****): bone biopsy shows in the upper portion a thick layer of connective (White Layer-WL) by using polarized light, in the lower part there is amorphous material (**). Under WL (interrupt line) there is bi-refringent spongy bone (MB);* ***B****): higher magnification of bone biopsy.*

The mineralized bone is strongly birefringent, if observed with polarized light, due to its anisotropic structure (Fig. 6A). They are no visible cellular elements indicating inflammation or immune reaction, in the connective tissue of the marrow.

The histological examination of the device shows its strongly birefringent structure, if observed with polarized light, due to its anisotropic nature, of the collagen framework, traceable to haversian cortical bone (Fig. 7C). No cellular elements are identifiable in its structure (Fig. 7B)

DISCUSSION

Vertical and horizontal bone defect is a challenge in oral surgery. Alveolar bone reconstruction is needed before implant insertion. Several surgical techniques are available.

The barrier device proposed in this clinical case is the Curved Soft Lamina (CSL), which is a demineralized porcine cortical bone sheet, with a thickness of ~ 1.0 mm. Previous studies demonstrate its effectiveness in horizontal GBR (8-10). In some works, the device is passively applied to the recipient site (15, 16) in others it is immobilized using fixation screws (17). According to manufacturer instructions, CSL should be directly grafted without hydration. It can be particularly effective in association with pre-hydrated collagenated cortico-cancellous granules (CCG) of porcine xenograft. For this reason, CCG has been chosen, as graft material, due to its natural micro-porous consistency which facilitates new bone tissue formation, in defect sites (18, 19) and accelerates the regeneration process. Further studies show that it is gradually resorbable (20, 21), preserving the original graft shape and volume due to its osteoconductive property (22). Moreover, thanks to its collagen content, the product facilitates blood clotting and the subsequent invasion of repairing and regenerative cells. In this clinical case, CCG has been used in combination with autologous bone, harvested from the ramus, to give osteogenic properties to the graft, with a ratio of 50% for each one, as is usually done in vertical GBR with no resorbable devices (23).

In our previous clinical experiences, if lamina is passively placed on the recipient site without previous hydration a hygroscopic expansion in the following postoperative days can stretch the sutured flaps leading to the wound dehiscence, thus compromising the outcome of bone augmentation procedure. For this reason, the pre-hydration and subsequent fixation of lamina was adopted to achieve a stabilization of the underlining graft over the time, which is in mandatory in case of GBR (4, 6).

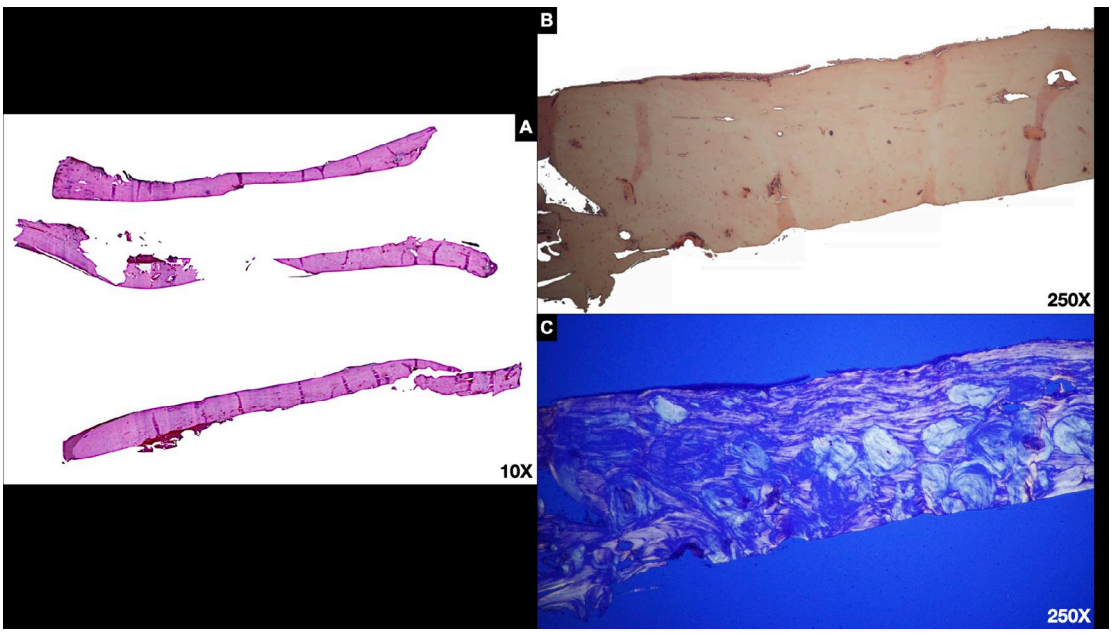

Fig. 7. *Histologic images – **A**): lamina a low magnification; **B**): lamina in standard light; **C**): lamina seen in polarized light. It is evident the anisotropic structure is due to collagen that is proper of harversian bone.*

CONCLUSIONS

Histological results suggest the validity of surgical procedure for bone volume regeneration in the distal mandibular region. Furthermore, according to our clinical experience, both the pre-hydration and stabilization of the device, with fixation screws, is strongly recommended, if vertical bone regeneration is needed.

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