The three-dimensional reconstruction of the jaw with "bone slat technique" in conjunction with third molar removal

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Summary

Background. **The purpose of this study was to report the outcome of the management of both horizontal and vertical defects of alveolar crest using the bone slat technique approach in conjunction with third molar removal prior to implant placement in the aesthetic area.**
Methods**. We present a 20-year-old female patient who lost a maxillary lateral incisor. The objective of treatment was to replace the lateral incisor with an implant-supported crown restoration without interfering with the integrity and topography of the adjacent gingival tissues. Because the future implant site showed horizontal and vertical bone defect the Authors decided to perform bone regeneration. The need for such bone augmentation in the younger patient often coincides with the timing for third molar removal. By combining third molar extraction with bone harvest and alveolar grafting, the patient undergoes only one surgical approach. The bone height (9.5 mm) and width (5.7 mm) were measured at the point of interest (tooth 12) both before and after implant placement in the reconstructed panoramic and parasagittal views by Cone Beam Computed Tomography (CBCT) scan.**
Results**. The final results demonstrated an increase in length of 5 mm after bone slat technique (from 9.5 mm to 13.5 mm) and an increase in width of 1 mm (from 5.7 mm to 6.7 mm). ISQ measurements were recorded at the time of implant placement (the mean was: 68.5) and immediately after individualized screw-retained provisional crown (the mean was: 77).**
Conclusions**. This technique is reliable and aesthetic and functional results appear to be stable and respect this requisite: simple and fast graft harvesting and low risk of morbidity especially in conjunction with third molar removal.**

Key words: alveolar ridge augmentation, alveolar bone grafting, esthetics, bone slat technique.

Introduction

The bone available for the implant placement may be insufficient due to tooth extraction, trauma, periodontitis, infection, or the long-term use of removable prostheses (1, 2). This resorption of the alveolar crest often reduces the possibility of correct three-dimensional implant placement for teeth replacement.
Severely resorbed alveolar bone requires a ridge augmentation procedure to achieve the appropriate width and height of bone to enable successful implant placement.
Therefore, preparation of the implant site can require augmentation with autologous bone grafts. Different extra- and intraoral donor sites are available (3-6). Other techniques used to treat bone defects and that can be utilized: edentulous ridge expansion, guided bone regeneration and sandwich bone osteotomy (7, 8). As well as, several Authors used connective tissue graft to improve the aesthetic results (9, 10).
The purpose of this article is to present the application of a new procedure for reconstruction of the atrophic maxilla in conjunction with third molar removal: three-dimensional reconstruction with bone slats of about 1 mm thickness taken directly from the donor site; space between the bone slats and the alveolar bone was filled with bone chips harvested by bone scraper.
This technique is reliable and aesthetic and functional results appear to be stable and respect this requisite: simple and fast graft harvesting and low risk of morbidity especially in conjunction with third molar removal.

Case description

The requirements of the Helsinki Declaration were observed and the patient gave informed consent for all surgical procedures. A 20-year-old female patient was referred to the Authors to save her maxillary right lateral incisor. The tooth was slightly mobile (grade 2), vital, and extremely sensitive to palpation. Radiographic examination (panoramic) revealed a marked bone loss. This rapid bone loss was pathognomonic for aggressive periodontal disease (Fig. 1). The prognosis of the tooth was hopeless, and it was destined for extraction. Moreover, the patient presented agenesis of 18 with inclusion of 28, 38 and 48.
After the diagnostic work-up was completed, a treatment plan was developed using a specialist team approach. The proposed treatments included orthodontic treatment and tooth replacement by implantology. In fact, orthodontic therapy can improve the periodontal situation in patients with pathologic migration by providing good function and improved aesthetics after realignment.
The maxillary right lateral incisor was extracted and the extraction socket was carefully curetted. The crown of the extracted tooth was used as a temporary tooth and was pegged to the orthodontic device during orthodontic alignment with arch wire technique applied to the brackets.
The objective of treatment was to replace the lateral incisor with an implant-supported crown restoration without interfering with the integrity and topography of the adjacent gingival tissues. Because the future implant site showed horizontal and vertical bone defect the Authors decided to perform bone regeneration.
The need for such bone augmentation in the younger patient often coincides with the timing for third molar removal. By combining third molar extraction with bone harvest and alveolar grafting, the patient undergoes only one surgical approach.

Surgical planning

A single X-ray (Vistascan mini view - DURR dental, Bietigheim-Bissingen, Germany) of region 12 (FDI tooth numbering system), and Cone Beam Computed Tomography (CBCT) scan (Scanora 3D - SOREDEX, Tuusula, Finland) were performed to plan the surgical procedure.
The CBCT scan revealed a great vertical and horizontal bone dehiscence of both buccal and palatal plate in the maxillary right lateral area with a bone density of D5 using Misch's classification (11) (mean 32 HU). The bone height (9.5 mm) and width (5.7 mm) were measured at the point of interest (tooth 12) both before and after implant placement in the reconstructed panoramic and parasagittal views (Fig. 2).
Surgical procedure was performed under local anesthesia (mepivacaine 2% + epinephrine 1:100.000) plus oral sedation (midazolam 5 mg). The patient was premedicated 1 hour prior with amoxicillin plus clavulanic acid 2 g orally. Immediately before surgery, the patient rinsed his mouth with a 0.3% chlorhexidine solution for one minute.

Recipient Site

A crestal incision slightly shifted on the palatal was followed by a sulcular incision from the tooth 11 to the tooth 13, with one relieving incision that the mesial line angle of tooth 11 extending along the upper labial frenulum. A full-thickness flap was elevated, and all inflammatory and granulation tissue were debrided with a curette. The incisive nerve was saved. To ensure tension-free wound closure, the periosteum was slit basal of the flap immediately before surgery, to prevent bleeding at the time of suture. The bony defect was measured using a periodontal probe to determine the size of the bone slat (Fig. 3).

Donor Site

Flap design

Access to the ramus area for bone harvest was gained through an extension of the commonly used envelope flap for third molar removal: a buccal envelope flap with a sulcular incision was performed from the first to the second mandibular molar with a distal incision along the mandibular ramus.

Figure 1. Clinical preoperative situation. Preoperative panoramic radiographic analysis.

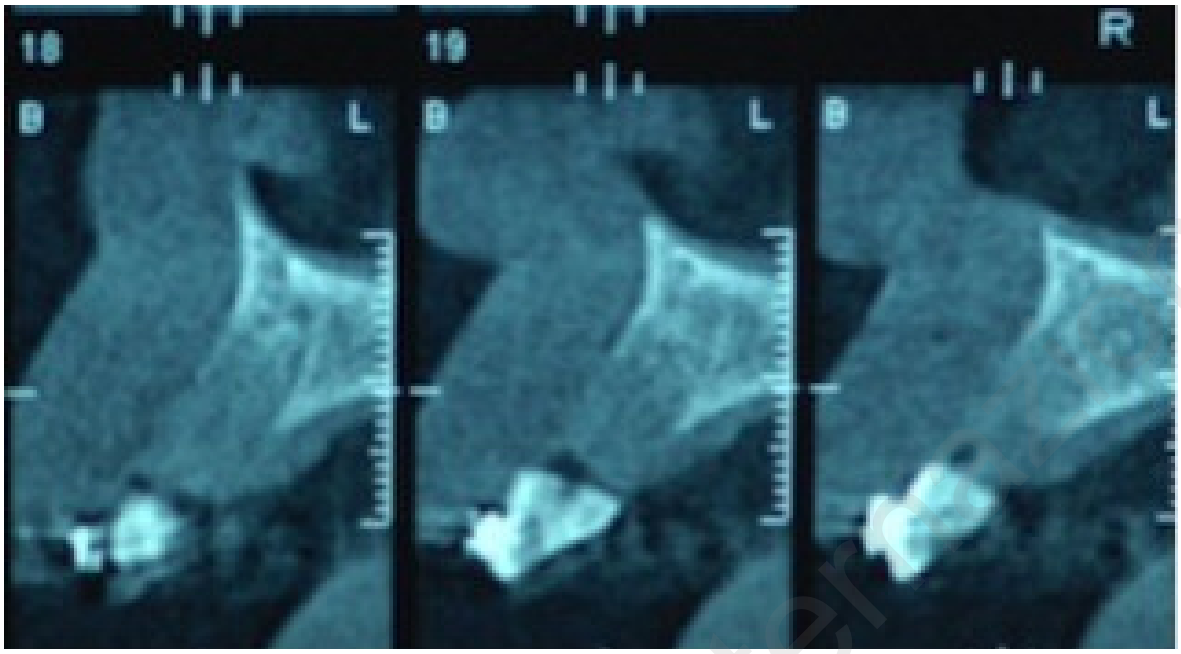

Figure 2. Presurgical CBCT study in the area of maxillary right lateral incisor.

Figure 3. The bony defect was measured using a periodontal probe to determine the size of the bone shells.

The mucoperiosteal flap was reflected from the mandibular body, exposing the third molar area and buccal plate of the ramus. The flap was elevated superiorly along the external oblique ridge to the base of the coronoid process and stopped in this position using a klemmer.

Osteotomy

The osteotomy was performed following the Piezosurgery (Mectron, Genova, Italy) technique. The bone was harvested, to obtain the bone slat of about 1 mm of thickness from the buccal plate. A thin chisel is gently tapped along the entire length of the external oblique osteotomy, taking care to parallel the lateral surface of the ramus. This technique leaves intact the bone medullary of the mandible preserving the integrity of the underlying mandibular nerve (Fig. 4).
After, by the use of a bone scraper (safe scraper twist, Meta, Reggio Emilia, Italy), the bone particles were collected for later use.

Bone graft placement

The bone slats were anchored in the host bone with titanium microscrews (Stoma Set, Germany) (Fig. 5). Space between the bone slats and the alveolar bone was filled with bone chips harvested by bone scraper (safe scraper twist, Meta, Reggio Emilia, Italy) (Fig. 6). The bone graft was covered with a mucoperiosteal flap and the wound was closed with interrupted sutures.
The mesial and distal alveolar contours were considered as reference points for adaptation of the bone slats.

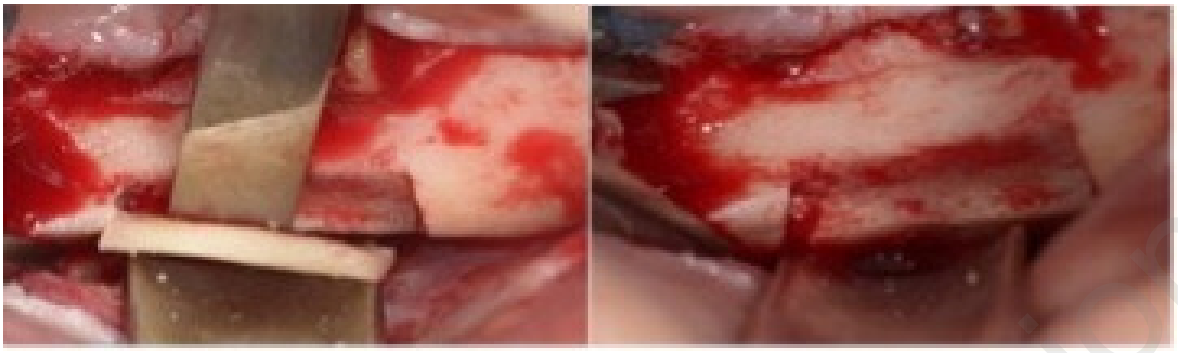

Figure 4. A thin chisel is gently tapped along the entire length of the external oblique osteotomy, taking care to parallel the lateral surface of the ramus. This technique leaves intact the bone medullary of the mandible preserving the integrity of the underlying mandibular nerve.

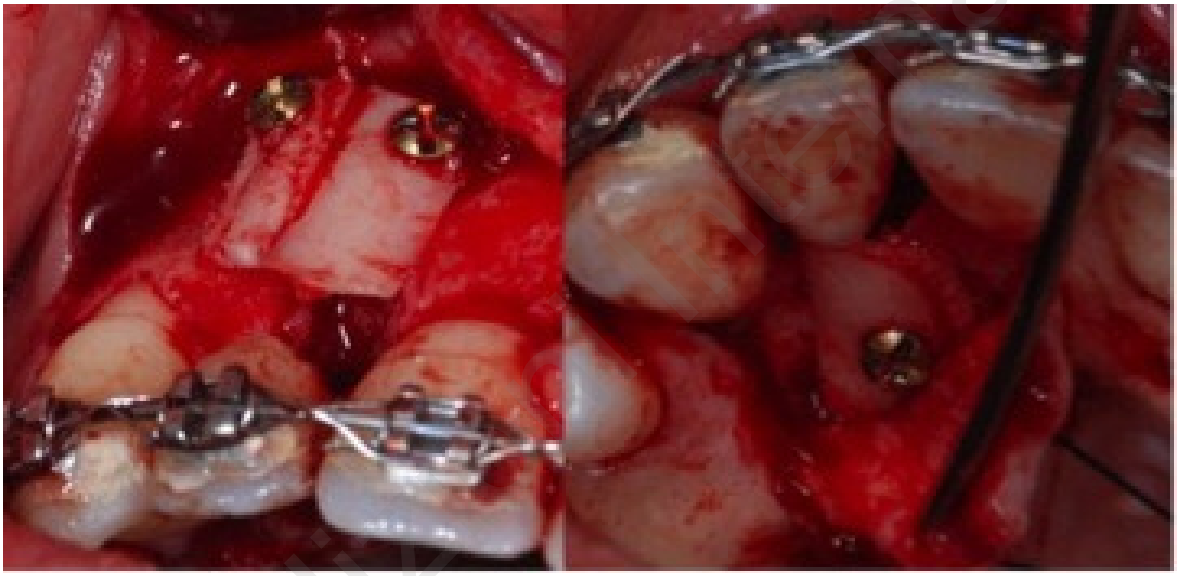

Figure 5. The bone slats were anchored in the host bone with titanium microscrews.

Third molar surgery
Because the third molar tooth was completely impacted, it was helpful to procure the graft first to visualize the submerged crown. After the bone harvest performed, the third molar was removed, the socket was inspected, dental follicular tissue was curetted, the socket was irrigated copiously with normal saline, the flap was then repositioned and sutured (prolene 5/0, Ethicon).

Results

CBCT scan was performed 3 months after maxillary reconstruction. The CBCT scan showed reconstruction of both buccal and palatal plate and improvement of bone density from (32 HU) to (92 HU) according to Misch's classification (Fig. 7) (11). The final results demonstrated an increase in length of 5 mm after bone graft (from 9.5 mm to 13.5 mm) and an increase in width of 1 mm after bone augmentation (from 5.7 mm to 6.7 mm) (Fig. 8).

Implant Placement
After a 3-month healing period, re-entry surgery was performed for implant insertion.
Following local anesthesia (mepivacaine 2% + epinephrine 1:200.000), a standard mucoperiosteal flap was elevated including sulcular incisions at both teeth facing the single-tooth gap via a palatally oriented crestal incision. The osteosynthesis titanium microscrews were removed (Fig. 9). Thereupon, the patient received one commercially available implants: MIS Seven (MIS, Barlev, Israel) 3.75 mm of diameter and 13 mm of length. A correct 3-D positioning of the implant, as described by Grunder et al., was performed (12). At the time of surgery, small-diameter healing abutments were placed (Fig. 10). The mucoperiosteal flap was sutured at the mesial and distal aspect (prolene 5/0, Ethicon). Post-operative instruc-

Figure 6. Space between the bone slats and the alveolar bone was filled with bone chips.

tions included continued antibiotic treatment for 6 days and analgesic therapy. Oral disinfection was recommended for 2 weeks. Sutures were removed 10 days post-operatively.

Implant stability quotient

The implant stability coefficient, termed RFA analysis, was measured by Osstell (Integration Diagnostics AB, Goteborg, Sweden). It was necessary to screw a disposable magnetic attachment (Smartpeg™) to implant 4-5 Ncm. Magnetic attachment cannot have any contact with any metallic instrument before it is screwed. Smartpegs™ compatible with diameter 4.2 mm, 3.75 mm: seven implants (MIS, Barlev, Israel), system connection was used. ISQ measurements were recorded at the time of implant placement. Four different measurements were taken (facial or buccal, lingual, mesial, distal), and then an average value of these 4 values was taken; ISQ was: 68.5.

Figure 7. The CBCT scan showed reconstruction of both buccal and palatal plate and improvement of bone density from (32 HU) to (92 HU) according to Misch's classification.

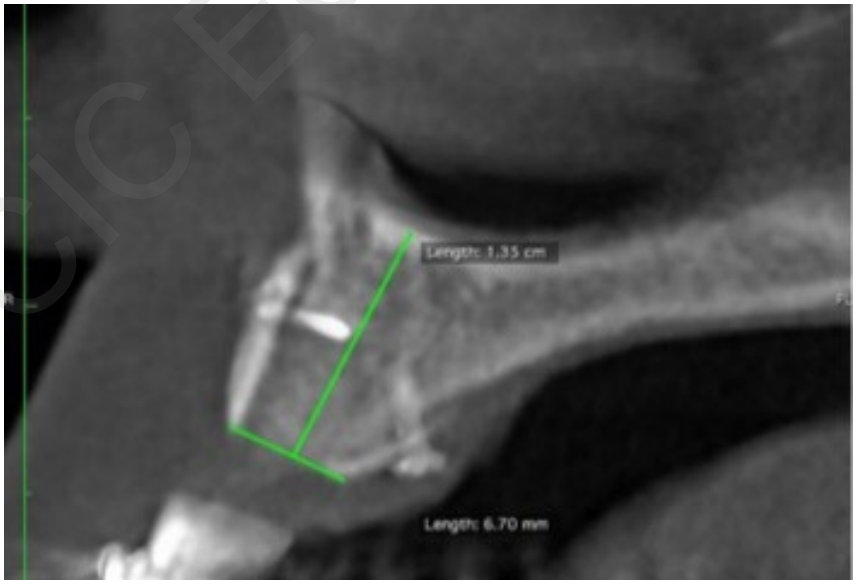

Figure 8. The final results demonstrated an increase in lenght of 5 mm after bone graft (from 9.5 to 13.5 mm) and an increase in width of 1 mm after bone augmentation (from 5.7 to 6.7 mm).

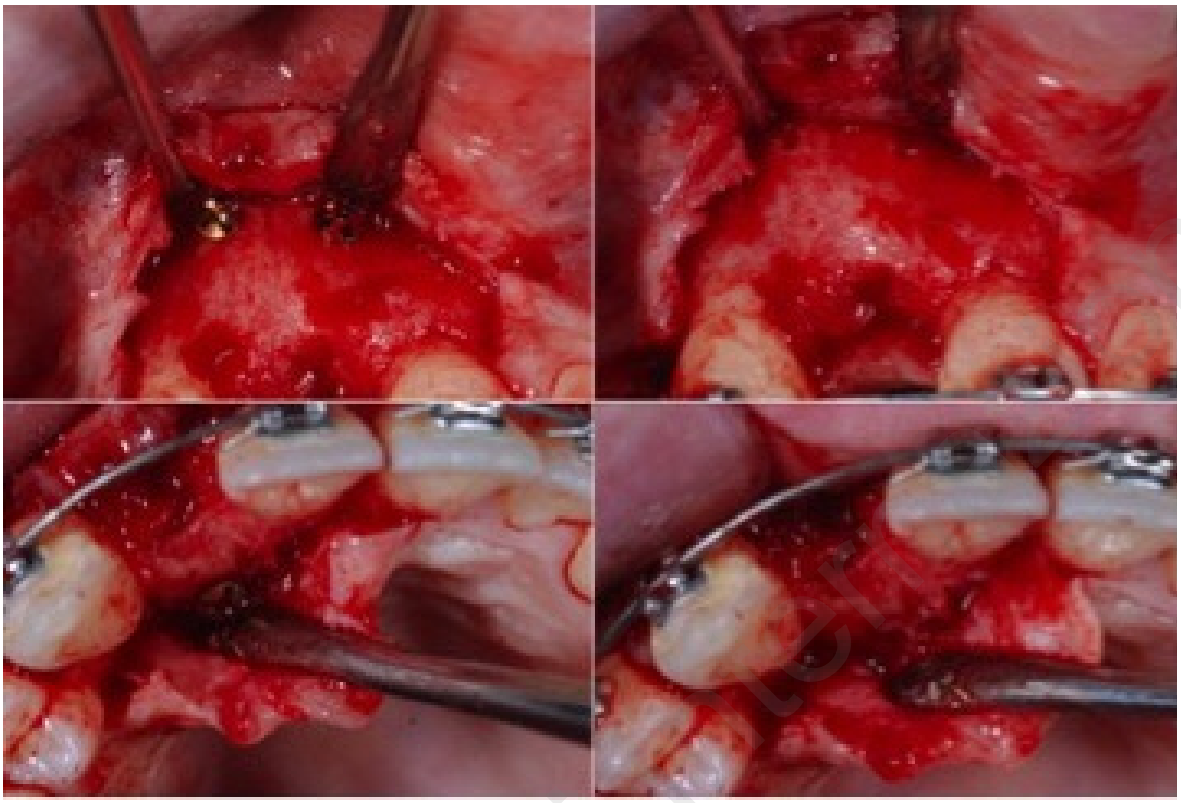

Figure 9. The osteosynthesis titanium microscrews were removed.

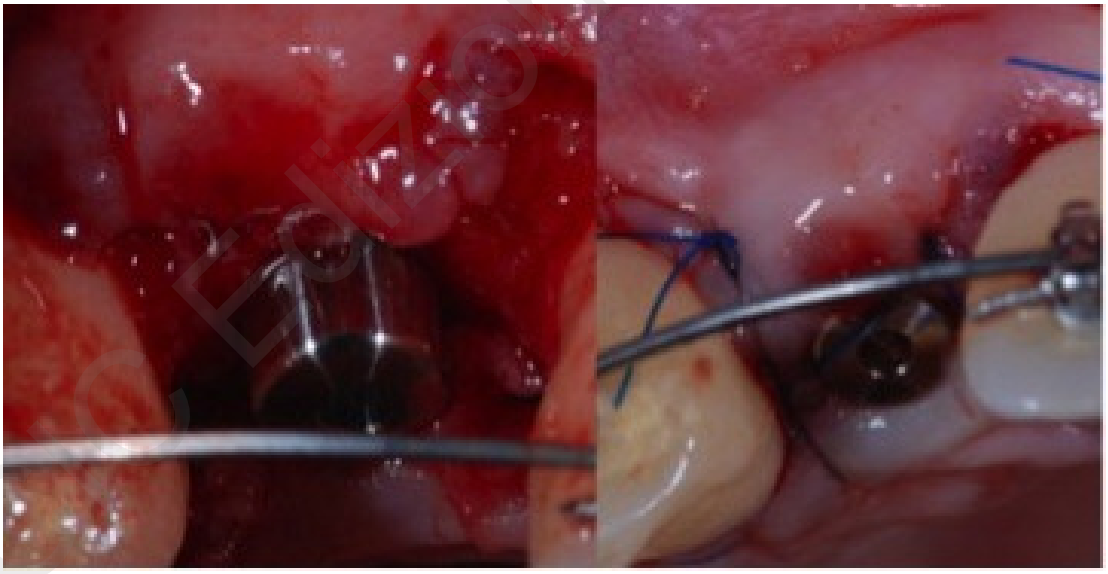

Figure 10. A correct 3-D positioning of the implant was performed. At the time of surgery, small-diameter healing abutments were placed.

Restorative Procedure

After 5 months from implant surgery a CBCT scan was performed immediately after individualized screw-retained provisional crown (Fig. 11) and ISQ measurements were recorded with 4 different measurements. The ISQ average of these 4 values was 77.

The CBCT scan showed reconstruction of both buccal and palatal plate and improvement of bone density from D5 (92 HU) to D2 (1246 HU) according to Misch's classification (Fig. 12) (11). The final results demonstrated an increase in length of 5 mm after bone graft (from 9.5 mm to 13.5 mm) and an increase

Figure 11. After 5 months post-op, one screw-retained provisional crown was delivered.

Figure 12. The CBCT scan showed reconstruction of both buccal and palatal plate and improvement of bone density from D5 (92 HU) to D2 (1246 HU) according to Misch's classification.

in width of 1 mm after bone augmentation (from 5.7 mm to 6.7 mm) (Fig. 13).

Discussion

The use of bone removed from the posterior mandible during mandibular third molar extraction also has been described (13). The Author, in this clinical study, used the piezosurgery Medical device with surgical tip MT1S-10 (Mectron®, Carasco, Genova, Italy) to remove the third (14).

Khoury et al. (15, 16) described the shell technique for three-dimensional hard tissue grafting. Their technique included the harvesting technique followed the methodology of the MicroSaw. Thin cortical bone shells, harvested with a special cutting wheel (Micro-

Figure 13. The final results demonstrated an increase in length of 5 mm after bone graft (from 9.5 mm to 13.5 mm) and an increase in width of 1 mm after bone augmentation (from 5.7 mm to 6.7 mm).

Saw) from the retromolar region, were placed to reshape the alveolar crest and to protect the particular bone (placed in the cavity between the shells), from resorption. Harvesting the bone shells and extraorally trimming with a cutting wheel is very technique-sensitive. Additional, harvesting of bone chips is also necessary. In particular, the harvested bone block was cut along its long axis into two thinner blocks with the same diamond disk used previously. These two blocks were thinned to a thickness of 1 mm using a bone scraper; bone chips were collected at the same time.

The major advantage of this technique, in comparison to a bone block augmentation placed as an onlay graft, is the regeneration of vital bone (15, 16). The bone laminae of about 1 mm thickness prevent resorption of the bone chips and provide the shape of the graft. Blood supply from the host bone ensures survival of the bone chips.

Based on these biological concepts described by Khoury et al. (15, 16) we have made changes on the establishment of three-dimensional reconstruction of the atrophic ridge (6); in fact, the bone slat of about 1 mm thickness was obtained directly from the donor site by piezosurgery Medical device with surgical tip MT1S-10 (Mectron®, Carasco, Genova, Italy), and wasn't necessary his extraoral trimming. Furthermore, the intraoral bone lamina harvested was exclusive cortical bone (Fig. 4), this avoid the possibility of injury the inferior alveolar nerve with paraesthesia or anesthesia; or injury of the buccal nerve with decreased sensitivity in the posterior vestibular mucosa. Moreover, we performed the harvesting of the bone lamina of about 1 mm thickness directly from the donor site avoiding the possibility of the bone contamination and vitality stress during the cutting along its long axis into two thinner blocks with the diamond disk and bone scraper.

The final results of this clinical case demonstrated an increase in length of 5 mm after bone graft (from 9.5 to 13.5 mm) and an increase in width of 1 mm after bone augmentation (from 5.7 to 6.7 mm).
In addition, we observed an improvement of bone density after implant loading: from D5 (92 HU) to D2 (1246 HU) according to Misch's classification. We think that this improvement in bone quality is linked to the change of the bone architecture under load so that the bone structure will be able to support the chewing load.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

References

1. Lekovic V, Kenney EB, Weinlaender M, Han T, Klokkevold P, Nedic M, Orsini M. A bone regenerative approach to alveolar ridge maintenance following tooth extraction. Report of 10 cases. J Periodontol. Jun 1997;68(6):563-570.
2. Ong CT, Ivanovski S, Needleman IG, Retzepi M, Moles DR, Tonetti MS, Donos N. Systematic review of implant outcomes in treated periodontitis subjects. J Clin Periodontol. May 2008; 35(5):438-462.
3. Lundgren AK, Lundgren D, Hämmerle CH, Nyman S, Sennerby L. Influence of decortication of the donor bone on guided bone augmentation. An experimental study in the rabbit skull bone. Clin Oral Implants Res. Apr 2000;11(2):99-106.
4. Misch CM. Comparison of intraoral donor sites for onlay grafting prior to implant placement. Int J Oral Maxillofac Implants. Nov-Dec 1997;12(6):767-776.
5. D'Amato S, Tartaro G, Itro A, Nastri L, Santagata M. Block versus particulate/titanium mesh for ridge augmentation for mandibular lateral incisor defects: clinical and histologic analysis. Int J Periodontics Restorative Dent. Jan-Feb 2015;35 (1):e1-8.
6. D'Amato S, Tartaro G, Itro A, Santagata M. Mandibular bone regeneration after bone slat technique. Ann Stomatol (Roma). 3 Jul 2017;8(1):39-44.
7. Santagata M, Sgaramella N, Ferrieri I, Corvo G, Tartaro G, D'Amato S. Segmental sandwich osteotomy and tunnel technique for three-dimensional reconstruction of the jaw atrophy: a case report. Int J Implant Dent. Dec 2017;3(1):14.
8. Santagata M, Guariniello L, Tartaro G. Modified edentulous ridge expansion technique and immediate implant placement: a 3-year follow-up. J Oral Implantol. Apr 2015;41(2):184-187.
9. Santagata M, Tartaro G, D'Amato S. Clinical and histologic comparative study of subepithelial connective tissue graft and extracellular matrix membrane. A preliminary split-mouth study in humans. Int J Periodontics Restorative Dent. Jan-Feb 2015;35(1):85-91.
10. Santagata M, Guariniello L, Prisco RV, Tartaro G, D'Amato S. Use of subepithelial connective tissue graft as a biological barrier: a human clinical and histologic case report. J Oral Implantol. Aug 2014;40(4):465-448.
11. Misch CE. Density of bone: effect on treatment plans, surgical approach, healing, and progressive bone loading. Int J Oral Implantol. 1990;6(2):23-31.
12. Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics. Int J Periodontics Restorative Dent. 2005;25:113-119.
13. Misch CM. The harvest of ramus bone in conjunction with third molar removal for onlay grafting before placement of dental implants. J Oral Maxillofac Surg. 1999;57:1376-1379.
14. Itro A, Lupo G, Marra A, Carotenuto A, Cocozza E, Filipi M, D'Amato S. The piezoelectric osteotomy technique compared to the one with rotary instruments in the surgery of included third molars. A clinical study. Minerva Stomatol. Jun 2012;61(6):247-253.
15. Khoury F, Hanser T. Mandibular bone block harvesting from the retromolar region: a 10-year prospective clinical study. Int J Oral Maxillofac Implants. May-Jun 2015;30 (3):688-697.
16. Khoury F, Khoury CH. Mandibular bone block grafts: diagnosis, instrumentation, harvesting techniques and surgical procedures. In: Khoury F, Antoun, H, Missika P, eds. Bone Augmentation in Oral Implantology. Berlin: Quintessence, 2007.