Osteodistraction with dental implant - borne devices for bone regeneration in atrophied premaxilla

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Abstract

Various treatment strategies and techniques have been proposed to perform alveolar bone augmentation: most common are GBR (Guided Bone Regeneration) by autologous or eterologous bone grafting. All of these techniques have regenerative properties of osteoinduction and osteoconduction with a hierarchy in bone regenerative techniques in relation to regenerated bone survival as reported in literature.

Aim of this work is to show the evolution of an innovative technique for tooth-implant supported bone distraction for proper oral rehabilitation in atrophic premaxilla or alveolar bone.

Five patients affected by severe ridge atrophy secondary to previous extractions were selected for surgical correction of the deficit improving implant support and aesthetic. Patients were clinically and radiographically studied and analyzed at different times before and after surgery.

Results were optimal from both functional and aesthetic point of view with complete recovery of the smile.

Alveolar ridge distraction osteogenesis is one of the available techniques for vertical and transversal restoration of atrophied alveolar bone achieving the new formed bone from the native basal bone. For this reason the advantages of the alveolar and basal bone distraction techniques are related to the long-term stability for the new regenerated bone. Distraction techniques show basic advantages in long-term stability of the regenerated bone even if different methods are reported in the literature without a well recognised scientific agreement on the distraction technique selection. Each different distraction technique is related to different advantages and disadvantages which has to be properly managed by a skill surgical, orthodontic and prosthodontic team.

This technique is particularly suitable in association with short implant use showing the potential to become widely used in bone height augmentation alone and in cases with dental implants already installed and osteointegrated in wrong position.

Introduction

Acquired alveolar defects may be caused by post-extraction defects; traumatic tooth avulsion, periodontal disease, and prolonged denture wear with subsequent atrophy. In the largest part of the cases the most significant loss is in the horizontal dimension. With the rapid advancement of dental implant therapeutics, the current trend is more geared toward enhancing esthetics and maximizing patient comfort and satisfaction.

Only with sufficient alveolar bone support implant supported prosthesis can achieve satisfactory aesthetic results.

Differently from horizontal bone augmentation easily achieved with current techniques, vertical bone augmentation still constitutes an unsolved problem in pre-prosthetic surgery. Problems using current autologous grafting or GBR (Guided Bone Regeneration) techniques are related to poor stability of gained vertical bone height and graft exposure for suture dehiscence frequently due to partial or total bone graft necrosis in on-lay techniques. To avoid bone exposure, mucosal incisions are usually performed far from graft site and graft sharp margins are accurately trimmed: even in cases where these methods are properly followed, bone graft exposure may happen because of total or partial graft necrosis due to many different reasons such as lack in graft stability for improper fixation, limited bone contact between graft and recipient site for lack in shaping, mucosa perforation due to flap tension or sharp graft margin. All these situations will lead to infection, or lack in bone graft nourishing with subsequent necrosis. For these complications and for lack in long term bone graft stability related to autologous onlay bone grafts or GBR techniques we selected the distraction technique for alveolar bone augmentation. This technique will assure long term stability even if showing a high rate complications incidence from literature.

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Another reason for alveolar bone expansion comes from recent scientific literature demonstrating long term implant survived can be achieved only with an alveolar cortical walls thickness of almost 1.5-2.0 mm on both buccal and lingual/palatal sides.

Also preserving aesthetic of the smile even in intermediate postoperative implant surgery is a paramount factor for the patients in selecting treatment planning and for acceptance.

Because of the different relationship between alveolar bone and basal bone in the jaws, alveolar bone atrophy will result in a centripetal trend in the maxilla and a centrifugal trend in the mandible. This regressive process that involves the alveolar bone changes in the quality and quantity frequently leads to class III relationship and reduction of the coating soft tissue, with the reduction of fixed keratinized gingiva often collapsed in a crestal cord and exuberance of mobile alveolar mucosa. This regressive process can cause difficulties during the oral intubation for general anesthesia.

In these cases it is necessary to adopt bone regeneration techniques in order to restore lost tissues, thus allowing adequate implant positioning, particularly in more extensive implant cases with frontal teeth restoration. Most common techniques for alveolar bone augmentation are guided bone regeneration (GBR) and autologous bone grafting. Particularly, GBR retrospective studies recently demonstrated long-term resorption for regenerated alveolar bone after GBR using heterologous bone.

Also for onlay autologous bone grafts an immediate post operative expected resorption rate of about 30% is commonly recorded in clinic with an overcorrection need for implanted bone graft to balance this resorption due to revascularization and bone cells colonization of the graft. Bone resorption of the graft will go on at different rates in the post implanted sites in relation to different techniques.

There is a hierarchy in bone regeneration related to long-term stability that can be classified from best to worse as follows: 1) native bone, 2) osteodistacted bone, 3) autologous bone grafts following sandwich in-lay technique, 4) autologous bone graft following the on-lay technique, 5) homologous bone, 6) heterologous bone, and 7) alloplastic bone substitute. The techniques that use these kinds of autologous bone or bone substitutes have different regenerative properties of osteoinduction and osteoconduction.

Chiapasco et al. [2] reviewed publications related to augmentation procedures to evaluate the success rate of different surgical techniques for the reconstruction of the deficient alveolar bone and the survival/success rates of implants placed in the reconstructed areas. Success rates of surgical procedures ranged from 60% to 100% for GBR, 92% to 100% for onlay bone grafts, 98% to 100% for ridge expansion techniques, 96.7% to 100% for distraction osteogenesis, and 87.5% for revascularized flaps. Survival rates of implants ranged from 92% to 100% for GBR, 60% to 100% for onlay bone grafts, 91% to 97.3% for ridge expansion techniques, 90.4% to 100% for distraction osteogenesis, and finally 88.2% for re-vascularized flaps.

Vertical autologous bone grafting appears to be a relatively reliable reconstructive technique, but it needs autogenous bone harvesting, which increases operating times and postoperative morbidity. In addition, early membrane exposure may cause infection that may compromise the final outcome of the rehabilitation. This technique has been mainly applied to limited defects with vertical bone gains ranging from 2 to 7 mm, on average.

Because of the unpredictability of long term results for autologous and heterologous surgical bone augmentation surgery more attention has been recently paid to osteodistraction for alveolar ridge augmentation.

Distraction osteogenesis has proven to be a reliable technique by some authors, because the vertical bone gain may reach more than 15 mm.

Osteodistraction is a clinical reality available for the resolution of bone deficiencies before dental implant placement or in cases where the existing implants are at the wrong position.

Additional advantages of this technique consist in soft tissue augmentation by the histo-distraction process in addition to osteodistraction. In this way it is possible to achieve in one surgical step both alveolar bone augmentation and soft tissue and attached gingiva augmentation in proper position.

In this study, we propose an innovative technique for the treatment of resorbed alveolar bone up to correction of atrophied edentulous premaxilla through osteodistraction with dental/implant borne devices.

Aim of this work was to show the evolution of an innovative technique for tooth-implant supported bone distraction leading to proper oral rehabilitation in cases with atrophic alveolar bone, whether in cases with already inserted implant in wrong position, or in cases with complete premaxilla expansion need.

Distraction technique [4,5] was selected because of the moderate invasiveness of the surgical step with a proper balance cost/benefits as in young patients with aesthetic exigency related to active social and working life as in elderly patients for lower surgical stress and risks.

In this situation a three jack screw individualized device was casted on device buccal and palatal arms: two jack screws on both sides at the buccal aspect and one single screw on the palatal side.

Material and methods

5 patients were referred to our Department with severe ridge atrophy secondary.

The patients' past medical and social history was non-contributory, and they all had good oral hygiene. All the patients had no contraindications to implant placement.

Patients with systemic or psychological disorders that contraindicate oral surgery were excluded from the study; also neoplastic pathologies or previous treatments with bisphosphonate drugs were considered exclusion factors.

All patients were informed of the study protocol and surgical risks: a written consent was obtained in all cases explaining alternatives, vantages and disadvantage of the surgical intervention.

The study was conducted in accordance with the ethical principles provided by the Declaration of Helsinki and the principles of good clinical practice.

All surgeries have been performed on outpatient base, with i.v. deep sedation.

Postoperative therapy required good oral hygiene, rinsing with mouthwash containing 0.2% chlorhexidine solution twice a day to enhance plaque control, and an evening application of the same product in gel form, as well as the administration of a non-steroidal anti-inflammatory aid (Ketoprofen 80 mg) for three consecutive days.
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Routine radiographic documentation of the treated patients was obtained with cephalograms in lateral view, panoramic and intraoral radiographs taken preoperatively T0, at the end of the contention after distraction procedure T1 (3 month after active distraction), and annually thereafter T2. Results were detected for anterior and vertical movements by rx cephalograms in lateral view and clinical measurements on dental crowns between of adjacent teeth.

Case 1-2-5

The patients were referred affected by traumatic loss with extensive alveolar bone loss. Patients were previously treated by autologous bone graft from mandibular ramus grafted on the alveolar bone defect by onlay technique. After four months implant was inserted in the grafted site with successful integration but unacceptable final result. Aesthetic requirements of the anterior smile were paramount for this patients. Because of fix gingiva discover when smiling in this area patients request were a new treatment for aesthetic and anatomic restoration of the frontal alveolar bone. To avoid a new onlay graft with related risks of failure in an already implanted site, we adopted a distraction technique on the osteointegrated implant. We used a distractor with two orthodontic screws anchored by arms to natural teeth in the posterior aspect and acting on the implant crown on the anterior aspect. In the original technique proposed by Marcantonio arms device were connected to upper premolars and molars by self-curing acrylic resin; in our case we used orthodontic bands casted with the distractor arms to obtain a rigid system to avoid undesired orthodontic movements of the posterior teeth with full control of the distraction vectors. Distractor was made on patient dental model and after sectioning the segment to be distracted; movements were detected on the model. Full thickness osteotomy was performed on the alveolar bone around the implant site in a slightly exclusive way for allowing distraction, without severing or elevating the attached gingiva from palatal and buccal area. Active distraction started after 1 week latency from surgery and following rates at 0.8 mm per day divided in two different activation for each day. Distractor was based on two jack screws casted by their arms with four bands on upper arch natural teeth by rear arms and with the frontal arms connected to the implant crown to be distracted by acrylic resin.

End of distraction was gained after 8 days with vertical overcorrection. Full satisfactory final result was achieved by this technique with proper alveolar bone augmentation and with fixed gum parables at the same level with adjacent teeth for full recovery of the smile aesthetic.

Contenion time was 3 months long followed by device removal and definitive prosthesis rehabilitation by a new implant supported crown.

Case 3-4

A female patient of 40 years old (Figure 1) was referred for huge sagittal and vertical premaxilla atrophy with sagittal alveolar discrepancy, unacceptable aesthetic result with temporary prosthesis due to extreme bone atrophy. A male patient of 33 years old was referred for maxillary atrophy by post extraction defects of 22-23. The patient was treated for premaxilla bone atrophy and discrepancy by a distraction device composed by three jack-screws anchored to natural teeth by a proper direction of distraction set screws checked on dental models vertical and sagittal skeletal discrepancies were corrected.

After device positioning based on four natural teeth in the posterior aspect and on a temporary prosthesis on natural teeth in the premaxilla anterior aspect. Incision was performed at the mucogengival line of the buccal aspect from 14 to 24 areas for complete visualization of the osteotomy area. Two full thickness vertical osteotomies were performed between upper canine and first bicuspid on both sides paying attention not to elevate fixed gum on both sides to preserve vascular supply. Osteotomy was completed with a horizontal cut of the premaxilla palatine bone. Active distraction started after seven days latency from surgery and followed the common rates at 0.8 mm per day divided in two different activation for each day for the number of days needed for the final result achievement with over-correction. Distractor was based on jack screws casted with bands on upper arch natural teeth of the palatal side such achieving a rigid distractor device with full control of the distraction vectors. On the osteotomized premaxilla bone fragment device was connected by a temporary prosthesis anchored on the canine teeth and with one mini-screw for proper fixation and acceptable smile aesthetic during distraction time. End of distraction was gained after 11 days. Contention time was extended to 9 months because of the large discrepancy to be corrected and the bone thinness of the distracted segment. After contention with two microplates insertion in the buccal aspect for additional stability at the vestibuloplasty time, final prosthesis was applied on four implants. At two years after surgery full satisfactory and stable final result was achieved by this technique whether by the prosthodontist or the patient.

Results

All of the ten cases had good results: there were no problems at surgery time, post-operatively, and during the period of osteointegration. All implants achieved osteointegration with a good...
degree of primary stability.

In case 1 between T0 and T1 we detected 6 mm in vertical height increase and 1 mm advancement in both Rx cephalograms on lateral view and clinically.

In case 5 between T0 and T1 we detected 11 mm advancement in lateral view on cephalograms and same result in clinical examination on teeth crowns. No changes in vertical dimension of the fragment position.

Results were judged to be satisfactory by treating dentists, from both functional and aesthetic point of view.

Patients were fully satisfied about the final result. Results appear extremely stable at T2, 1 and 2 years from surgery thus confirming one of the most important advantage of the distraction technique in comparison to the other most common technique for alveolar bone augmentation like autologous bone graft and heterologous bone substitute grafts for GBR.

Discussion

Atrophic maxillary bony ridge with huge deficiency, in the vertical and sagittal dimensions, may be presented in cases with post-traumatic loss of teeth or improper extractions.

The vertical deficient alveolar ridge can, in some cases, be rehabilitated by means of implant supported prosthesis, but the positioning of dental implants without any surgical augmentation might result in placement of implants of a reduced length which have to be rehabilitated by extremely elongated crowns. The sagittal deficient alveolar ridge dictates dental implant inclination that may be inadequate to satisfy the fundamental biomechanical and aesthetic requirements.

Advantages of the alveolar and basal bone distraction techniques are related to the long-term stability for the new generated bone: most popular different technique for bone augmentation like autologous bone grafts or GBR by heterologous bone substitutes still shows high resorption rates in long post-operative follow-up [6]. From literature review result same resorption rates from different authors implying technique related limits instead of personal cases failure as referred from one of the main author for GBR [7]. For this reason distraction techniques show basic advantages in long-term stability of the regenerated bone even if different methods for distraction are reported in the literature without a well recognised scientific agreement on the distraction technique choose. The use of a bone distractor device can promote a bone-volume increase and stimulates the surrounding soft tissues to grow together with the bone, preventing the onset of scar tissue [8-11]. This effect is called histogenic distraction, and can decrease the effects of an abrupt expansion of the soft tissues occurring in different tissues including skin, blood vessels, nerves, muscles, tendons, cartilage, and the periosteum [12].

Another advantage of this dental-implant supported distraction technique is related to the possibility of the device insertion in difficult areas where the adjacent dental roots presence don’t permit the screw insertion for bone anchored devices. Also aesthetic of the frontal smile is preserved using natural teeth anchored devices acting on implant supported crowns thus preserving acceptable frontal smile aesthetic by temporary crowns during distraction.

Each different distraction technique is related to different advantages and disadvantages which has to be properly managed by a skill surgical, orthodontic and prosthetic team.

Alveolar ridge distraction osteogenesis is one of the available techniques for vertical and transversal restoration by the new formed bone as at the origin of the alveolar and basal bone.

From literature review alveolar and basal bone distraction techniques were affected by a high rate of complication incidence. They were divided in major and minor complications [13]. Even in cases of major complications as mandibular fractures or distracted bone fracture, if well managed they did not lead to treatment interruption or failure. For this reason it is important adequate experience and skillness for the surgical team to overcome or prevent possible complications related to the procedure. To achieve most of the advantages avoiding as much as possible of the problems related to the distraction technique we adopted a combination of dental/implant borne device for distraction of an aesthetic area of the smile like premaxilla. With the selected technique of dental/implant supported distraction no major or minor complications were detected in our cases.

Conclusion

In the alveolar distraction with dental-implant distraction devices [14] it is possible to gain the full control of the distraction vectors, with an almost simple method with few surgical steps and with the possibility to apply temporary prosthesis during distraction time to preserve acceptable aesthetic of the smile for social life.

Advantage of this dental-implant distraction technique is related to possibility of working in difficult areas for the other commonly used bone-borne devices related to 1) aesthetic of the frontal smile, 2) thinness of the alveolar bone, 3) root presence of adjacent teeth preventing bone screw insertion for bone-borne devices and 4) long term stability of the new generated bone and soft tissues gained in the proper position.

This technique is particularly suitable in association with short implant use showing the potential to become widely used in bone height augmentation alone and in cases with dental implants already installed and osteointegrated in wrong position. This technique is also particularly suitable for the fastness of aesthetic and functional rehabilitation in heavy alveolar atrophy, first planning implant insertion with crown rehabilitation followed by tooth-implant supported bone distraction for final result refinements after achieving proper bone height and volume.

In the treatment of huge sagittal and vertical alveolar atrophy further evolution of the technique in consideration of recent advancement will be the association of the split crest first following the Cortese technique for alveolar transversal correction, followed by the dental-implant distraction for final vertical bone correction [15-18].

References


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