RECONSTRUCTION OF ALVEOLAR BONE DEFECT WITH AUTOGENOUS CORTICO-CANCELLOUS BONE MIXTURED WITH ALLOGENEIC MINERALIZED BONE GRAFT
(Case report)

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Abstract

In cases of advanced alveolar bone loss frequently associated with periodontal pockets that may not be accessible by conservative therapy, corrective surgery is often indicated as osseous resective and complete debridement therapy. Transplantation of osseous fill material is often necessary, as a surgical intervention may create an alveolar bone defect. In this reported case of surgery, a cortico-cancellous bone graft taken from the mandibular symphysis was transplanted in a mixture with human mineralized bone from the Dr. Soetomo Hospital Surabaya Bone Bank, expecting for osseous regeneration to reduce the bony defect. Six months after surgery the morphology of the reconstructed alveolar process was satisfactory and showing new growth of bone.

Keywords: Alveolar bone loss, mandibular symphysis donor site, cortico-cancellous bone graft, allogeneic mineralized bone graft, intramembranous bone.

Introduction

Surgical treatment of periodontal diseases has had a long and varied history. In a case of advanced periodontitis, alveolar bone loss can be associated with periodontal pocket that may not be accessible by conservative therapy, and then a surgical intervention might be necessary.

In surgical intervention to eliminate a periodontal pocket, gingival tissue preservation should be done carefully in order to preserve as much of the gingival tissue as possible. A surgical technique of inverse bevel has been developed to create a form of gingival in beveled form by cutting the edge of the gingiva involved with pathological condition or inflammation, and as a result, the

inflamed tissue could be removed preserving most of the healthy gingiva.[1]

Treatment of intra-bony defects due to erosion of the supporting alveolar bone has often resulted in the gingival tissue being repositioned apically. This situation may expose the root surfaces resulting in a cosmetic problem and dental hypersensitivity.In a case of osseous resective therapy, a complete therapy could be supplemented by osseous fill materials to achieve true healing of the periodontal pocket. Various regenerative techniques have been advocated. These can be divided into two groups:[1] 1. Bone grafting or infill techniques using tissue-derived products or synthetic materials to encourage new bone and supporting tissues to grow into periodontal pockets after surgical exposure and debridement; 2. Regenerative techniques using barrier membrane, this technique is usually used to prevent downgrowth of gingival cells into the healing wound, enabling periodontal and osseous tissues to regenerate.

As proposed by Dragoo[2], in alveolar bone loss associated with periodontal pocket which is not accessible to conservative therapy, osseous resective therapy and complete debridement therapy, supplemented by implantation of osseous fill material is said to be necessary. Osseous implant therapy is indicated as the surgical therapy of choice and often centers on osseous regeneration. Various grafting materials have been used to graft the alveolar process.

These grafting materials include autogenous bone materials such as cancellous and cortico-cancellous, others are allograft materials such as hydroxyapatite, and allograft bones such as demineralized or mineralized bone.It has been proposed by some authors[3,4] that formation of new bone can occur along three different pathways, as osteogenesis, osteoconduction, and osteoinduction. Osteoinduction involves new bone formation from osteoprogenitor cells derived from primitive mesenchymal cells under the influence of one or more inducing agents, which emanate from bone matrix.[3] Osteoinduction is one of the processes by which homologous (allogeneic) graft forms bone.[5]

Autogenous bone should be used as the first choice of the implant material because this type of bone has a regeneration potential when placed in an advanced bony defect. The most effective form of bone for bone grafting is cancellous cellular bone which can be taken from a donor site that has a high cellular component, such as ilium.[6] External root resorption has been described after the use of iliac crest cancellous bone grafts in cleft patients operated after eruption of the canine.[7-9] By applying an intramembranous mandibular bone graft, the incidence of complications were reduced, and resorption was first indentified 4 to 6 years after bone grafting.[10]

The mechanism of bone formation in a cancellous cellular bone (CCB) graft emanates from the survival of the osteoprogenitor cells within cancellous marrow, namely the endosteal osteoblasts and marrow stem cells transferred with the graft material.[11]

Knighton *et al* in 1984 proposed that the transplanted osteoprogenitor cells survive within the recipient tissue within the first 3 to 4 days by nutritional diffusion of nutrients from the surrounding vascular tissue envelope. By day 3 capillary buds from the surrounding tissue develop in response to the hypoxia within the graft, establishing an oxygen gradient between the graft and the surrounding vascular tissue which together with the acidosis and lactate present within the graft signals macrophage elaboration of macrophage-derived angiogenesis (MDAF).[5] From day 3 to about day 14 vassels permeate the graft to accomplish a complete revascularization. Once the graft is revascularized, the blood flow eliminates the oxygen gradient as well as the acidosis and lactate so that the macrophages cease to elaborate MDAF, thereby preventing overvascularization and maintaining a steady state.[12]

Gray and Elves in their 1979 experimental study stated that the endosteal osteoblasts survive transplantation and proliferate new osteoid upon the surface of the cancellous bone trabeculae.[5] The osteocytes within the bony trabeculae do not survive transplantation owing to their delicate cannicullar blood supply. Therefore, the mineral component undergoes a gradual physiological resorption mediated by osteoclasts. As osteoclasts resorb the bony trabeculae they release bone morphogenic proteins (BMP) from the noncollagenous mineral matrix bone, which in turn directs the stem cells transferred with the graft, stem cells within the local tissue, and circulating stem cells to differentiate into functional bone-forming cells.[5]

The current concept of bone regeneration of cancellous cellular bone graft healing involves a two phased theory of bone regeneration.The first phase (I) of bone regeneration arises from surviving endosteal osteoblasts and marrow stem cells transferred with the graft material which forms bone in a random haphazard fashion. The revascularization dependens on resorption of

transplanted bony trabeculae in the early phase I bone, followed by a remodeling and replacement with new bone, termed phase two (II). Phase II bone begins about third week after placement of overlaps similar to phase I bone, but eventually replaces all phase I bone with a mature bone capable of self-renewal via an endosteum and periosteum of its own. Recent appreciation of cancellous bone graft healing indicates that the osteoblastic and induction theories are not mutually exclusive. The current concept of cancellous cellular bone graft healing involves a two phased theory and forms a foundation on which consistently successful bone graft systems can be built.[5,13]

Graft of mineralized bone powders or lyophilized bone chips show minimal bone healing and are in fact often resorbed without bone production. In contrast, demineralized bone grafts do not undergo resorption of their bulk during bone induction.[14]

A mixture of cancellous bone and synthetic material, or allograft bone is usually used to reduce the amount of autologous bone needed for the graft material. Studies have shown, in experimental models, that autologous onlay bone grafts to the atrophic maxilla are more acceptable, more readily revascularized, and heal with less difficulty than in allogeneic onlay grafts to the same defect.[1] Therefore the use of autologus bone graft should be considered as a choice of a graft material.

Consideration should also be made as cancellous bone has very little scaffolding effect and should not be used when one hopes to obtain osseous bulk by replacement or osteoinduction. Cancellous bone tends to be resorbed rather rapidly with very little net osseous bulk.[15] It should be used in combination with cortical grafting to help induce osteogenesis for three-walled discontinuity defects such as an alveolar cleft defect in the maxilla.[5]

Delloye[16] wrote that mineralized cancellous bone or cortico-concellous bone are frequently used as a bone graft and the main indication is a local loss of bone, such as a small skeletal defect. A mixture of cancellous bone and synthetic material or allograft bone is usually used to reduce the amount of autologous bone needed for the graft material.

The most effective form of bone grafting today is cancellous cellular bone from a donor site that has a high cellular component such as ilium The bone that is transplanted is therefore more of a cellular transplant than mineral transplant where new bone is regenerated from endosteal osteoblast and marrow stem cell transferred with the graft material.[6]

Various donor sites have been described in literature, including tibia, rib, and trochanter, but the iliac crest is the preferred donor site in most centers.[17] Some reports have been published on the use of the calvarium.[17-20] and the mandibular symphisis.[21] The major advantages of using the intramembranous bone graft is the reduction of the morbidity of harvesting bone graft.[20,21]

The present study has demonstrated satisfactory results from bone grafting alveolar clefts with mandibular bone grafts, without complications at the donor site.[10]

In this case report, the use of intramembranous mandibular bone graft was done with the expectation that the intramembranous bone graft might vascularize more rapidly than the endochondral graft. The graft material was grafted in the maxilla, which has a intramembranous bone type, and therefore less complications could be expected at the recipient site.

Case Report

A 40 year old man visited the Oral and Maxillofacial Surgery Clinic, Faculty at Dentistry at Airlangga University with chief complaints of recurrent abscesses and moveable superior left lateral incisor, and expected tooth extraction. Panoramic and periapical photographs showed a marked horizontal resorption of the alveolar process in the area between the upper left second incisor and the canine. Clinical features showed thickened of the marginal gingiva, a bluish-red vertical zone from the gingival margin to the alveolar mucosa. Gingival bleeding, suppuration, and tooth mobility were also present.

A clinical observation was done by careful probing with a periodontal probe. The location and extension of the periodontal pocket was found to be significant. The buccal wall of the left lateral incisor was found resorbed. Local traumatic occlusion and secondary infection were presumed to be the causes of the existing periodontal disease.

Planned treatment included general health observation, surgical curettage, alveolar bone freshening and reconstruction of the alveolar defect with an autogenous bone graft using mandibular symphysis bone as a donor source.

The patient was treated under local anesthesia; prophylactic antibiotic of Clindamycine was chosen. The antibiotic use was initiated one day before surgery and continued for approximately 1 week.
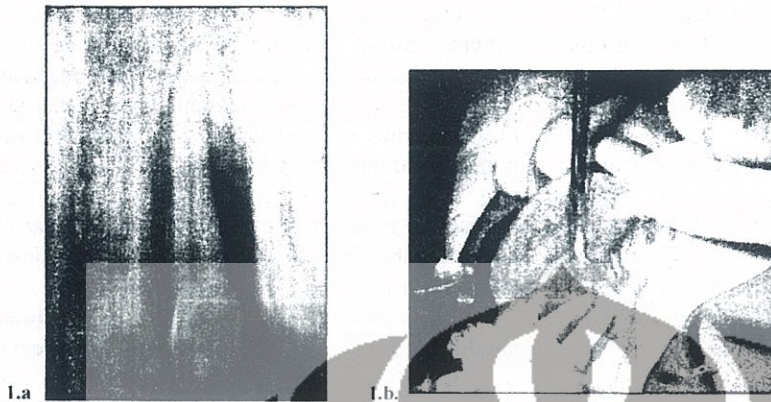
Fig. (1a). Periapical x-ray shows the alveolar bony defect in the region between left lateral incisor and canine,
(1b). Intra-operative situation after surgical curettage of the granulating tissue, bone graft delivered and
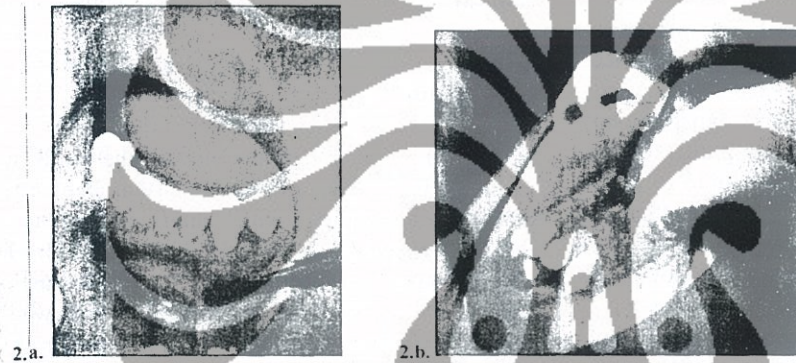

Fig. (2a). Fresh cortico-cancellous bone graft taken from the chin area,
(2b). The mixture of fresh autogenous cortico-cancellous and allograft mineralized bones placed in the defect area.
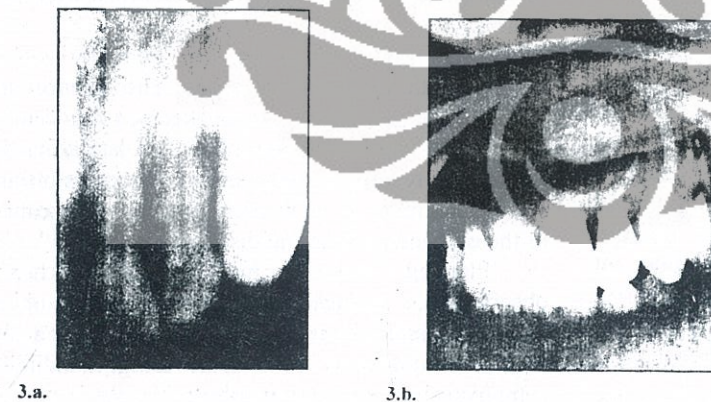

Fig. (3a). Periapical x-ray 6 months after surgery,
(3b). A six-month clinical situation after surgery exhibiting no periodontal complication.

A diverse rectangular incision from the left first incisor to the canine and sub-periosteal flap was made. A surgical curettage of the inflamed periodontal tissue was done, revealing an alveolar defect in the post-curettage areas, therefore alveolar bone reconstruction was presumed to be necessary.

A cortico-cancellous bone was taken from the chin area and was planned and prepared as a graft material. The cortico-cancellous bone was milled and used in the mixture for graft materials. A human bone allograft in a granulated form was also used in the mixture with a cortico-cancellous bone for a bone expander to fill the relatively large amount of bone defect.

The mucosal flap was then sutured back into its position using a 4.0 Vycryl suture material. The patient was observed periodically and six month after the surgery the wound was found successfully healed and the primary second incisor firmed. Radiographic examination showed that the alveolar process had grown new bone surrounding the left lateral incisor and canine (Fig.3a).

Discussion

This case report has demonstrated satisfactory result from bone grafting an alveolar defect with mandibular bone graft, without complications at the recipient and donor sites. Clinically no periodontal pocket or gingival recession was found in the surgical site.

Two possibilities might be suspected as involving in this case report, in which a pathologic condition arose where traumatic occlusion, bacterial intervention and a combination of these conditions led to alveolar bone destruction.

The most common form of alveolar bone destruction in periodontal disease is the extension of inflammation from marginal gingiva into supporting periodontal tissue induced by microorganisms in dental plaque. The inflammatory invasion of the bone surface and the initial bone loss that follows marks the transition from gingivitis to periodontitis.[22] The transition from gingivitis to periodontitis is associated with changes in the composition of bacterial plaque. In advanced stages of the disease, the number of motile organisms and spirochetes increase whereas the number of coccoid rods and straight rods decreases.[23]

Another cause of periodontal destruction is trauma from occlusion. Trauma from occlusion can produce bone destruction in the absence of inflammation. The changes caused by trauma from occlusion vary from increased compression and tension of the periodontal ligament to increased osteoclasis of the alveolar bone, necrosis of periodontal ligament and alveolar bone resorption. These changes are reversible in that they can be repaired if the offending forces are removed. Persistent trauma from occlusion results in a funnel shaped widening of the crestal portion of the periodontal ligament, with resorption of the adjacent bone. When combined with inflammation, trauma from occlusion aggravates the bone destruction.[22]

In terms of inflammation in the periodontal areas, these are related to the process of bone resorption. Patho-physiologically it can be explained that the host factors released by inflammatory cells are capable of inducing bone resorption in vitro and can play a role in periodontal disease. These factors include prostaglandins and their precursors, interleukin 1-Alpha and Beta and tumor necrosis factor (TNF)-Alpha.[22]

Some bacteria might also play a significant role in inducing periodontal diseases. In chronic periodontitis, the bacteria most often cultivated at high levels include, *P. gingivalis, B. fors-ythus, P. intermedia, C. rectus, Eikenella corrodens, F. nucleatum, A actinomycetemcomitans, P. micros, and Treponema* and *Eubacterium spp. Actinobacillus actinomycetemcomitans* is implicated as a pathogen in several forms of gingivitis and chronic periodontitis, most notably in localized aggressive periodontitis. *A. actinomycetem-comitans* posseses the ability to kill human leucocytes through production of a 116-kDa protein toxin termed as leukotoxin. Recent investigations have revealed a molecular basis for the variability in leukotoxin expression and led to new insights in the role of specific strains of *A. actinomycetemcomitans* in periodontitis.[24]

Also another microorganism, *Porphyromonas gingivalis,* is strongly associated with chronic and aggressive forms of periodontitis. The role of *P. gingivalis* in the destruction of the periodontal environment is its ability to degrade protein into short peptides that are taken in and used metabolically in the generation of energy and as sources of carbon and nitrogen. In the periodontal tissues the major protein constituent of periodontal tissues is collagen, and *P gingivalis* possesses the proteolytic activity to degrade collagen into peptide components. The bacterial collagenases, contribute to collagen degra-dation. Some peptidases that found in the cell surfaces of *P. gingivalis* are sufficient to degrade the collagen fragments include depeptidyl

peptidase IV (DPPIV) and prolyltripeptidyl peptidase (PtpA), proteases that generate di- and tripeptide fragments.[24]

Traumatic occlusion and bacterial intervention can be suspected to have influenced the pathologic condition of the presently reported case. The bone regeneration arises from cancellous cellular bone graft as explained by the mechanisms of phase I and II coupling. The apparent coupling of phase I to phase II bone formation is mediated by bone morphogenic protein (BMP). The success of bone grafting seems dependent on the process proceeded in phase I. The cellular cancellous bone seems to be the ideal graft system because it transplants the maximum number of osteoprogenitor cells to form phase I bone and a sufficient quantity of BMP to initiate phase II bone replacement for long-term graft results. Therefore a cancellous bone graft was used for the reconstruction process. A sufficient number of endosteal osteoblasts and marrow cells, as well as sufficient BMP was needed to form bony ossicle capable of self-renewal.[5,13]

As already proposed by some authors, mineralized bone powders can show minimal bone healing and are in fact often resorbed without bone formation.[14] Therefore this material was planned to be used only as a framework of the autogenous cortico-cancellous bone graft in reconstructing a large defect.

Conclusions

A cortico-cancellous bone graft taken from the mandibular symphysis with intramembranous type of bone, was transplanted in a mixture with human mineralized bone from the Dr. Soetomo Hospital-Surabaya Bone Bank and proved to reduce the alveolar bony defect by bone growth through osseous regeneration. Intramembranous bone type can be considered as a bone graft source for treatment of alveolar bone defects, when a bone substitution is needed. It was shown both in clinical and morphologic situation by six months after the surgical procedure, that the reconstructed alveolar process resulted in satisfactory healing. A new growth of bone at the recipient site was clearly seen in a periapical radiograph, and also the area of the donor site was healed with no complications.

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