Review Article

# IMPLANT SURVIVAL IN ATROPHIC MaXILLA AND MANDIBLE RECONSTRUCTED WITH FREE ILIAC GRAFT: A LITERATURE REVIEW

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**Abstract**

Prosthetic rehabilitation requires sufficient hard and soft tissues. Iliac bone transplants have been widely used for mandibular reconstruction. Due to their resistance to infection and large volume of bone that can be transferred, these grafts can be used to repair large bony defects and can also accept dental implants. So, the aim of the current literature review was to determine implant survival in atrophic maxilla and mandible reconstructed with free iliac graft using PubMed and Medline database English literature by the terms “Bone defects”, “Cervical bone resorption”, “Iliac bone”, “Implant survival”. Free iliac bone graft is considered to be a favorable alternative for the maintenance of satisfactory functional and esthetic results in patients with severely atrophied alveolar ridges. Autologous grafts of anterior iliac crest provide bone with high content of cellular bony components. Therefore it is considered the standard for reconstruction treatment of the different degrees of maxillary atrophy, since it allows sufficient corticocancellous bone volume, which is a requirement for success in pre-prosthetic surgery.

**Key words**: Bone defects, Cervical bone resorption, Iliac bone, Implant survival

## Introduction

Prosthetic rehabilitation requires sufficient hard and soft tissues. This aspect is of particular importance when the relationship of various anatomic units such as lips, mandibular vestibule, floor of the mouth, and mucosa of the alveolar process is considered following reconstructive surgery.[1] Defects due to severe trauma, such as gunshot wounds, in the floor of the mouth and the mandible have particularly long-lasting, detrimental effects on masticatory function. Hence, reconstructive measures have to be considered for regaining functions such as mastication and articulation, in addition to restoring esthetic integrity. Ensuring a soft-tissue lining, adequate oral intake, provision for a prosthesis, and satisfactory esthetic rehabilitation should be the major goals of reconstruction. In cases of severe trauma or excessively resorbed mandibular alveolar ridges, preservation or reinstatement of chewing ability makes a major contribution toward a certain degree of enjoyment of life. This rehabilitation not only necessitates transferring tissue to repair the defect but also enables prosthetic care.[2]

Despite the great progress in microsurgically anastomosed reconstructive graft surgery, these reconstructions often have extensive financial costs due to time and technical support and have their limitations as a result of restricted medical capacity or through a lack of compliance.2 Reconstructive procedures using free grafts, which have been known for many years, remain as an alternative to these modern concepts. Osteointegrated implants are also well known for the rehabilitation of maxillofacial defects.[3] Iliac bone transplants have been widely used for mandibular reconstruction. Due to their resistance to infection and large volume of bone that can be transferred, these grafts can be used to repair large bony defects and can also accept dental implants.[4] The cortical bone of the iliac crest is thickest at the ‘‘intermediate line,’’ but all parts of the iliac crest are thick enough to accept dental implants. Contrarily, rib grafts are not thick enough for the same purpose. That is why iliac bone is still one of the best sources for large bone grafts.[5] The patient in the second case presented in this article had had a reconstruction by rib graft. To support the buccolingually insufficient bone and to augment the crest, an iliac graft was preferred. Both cortical and cancellous bone can be obtained from the iliac crest. Preparation of the recipient site should be done before harvesting of the bone graft. This allows for determination of the amount of bone graft needed and the final selection of the appropriate donor site.[6] So, the aim of the current literature review was to determine implant survival in atrophic maxilla and mandible reconstructed with free iliac graft.

## Material and Methods

The keywords used for the literature search for this review was peer-reviewed articles following Bone defects x Cervical bone resorption x Iliac bone x Implant survival. Among them, the papers were fit the criteria selected and available full-text articles read. Related articles were also scrutinized. Hand search was also driven. The search was carried out using Biological Abstracts, Chemical Abstracts, and the data bank of the PubMed and Medline database updated to 2017. The references found in the search were then studied in detail.

## Guided Bone Regeneration

The predictability of dental implants as a treatment option to replace missing teeth has been concerned however the unavoidable bone loss takes place in the edentulous alveolar ridge over time often impedes the use of standard implant placement protocols and calls for alternative or additional procedures.[7] In this sense, the universal tendency nowadays is to minimize patient morbidity and increase patient acceptance of the rehabilitation procedure by using graftless solutions or nonautogenous sources of graft material.[8] In cases of mild to moderate resorption, shorter and narrower implants as well as angled implant placement may be effective strategies to avoid bone grafting. Nevertheless, a deficiency in residual bone volume frequently must be addressed.[9] Many techniques introduced for regenerating damaged periodontal tissues.[10] Guided tissue regeneration (GTR) therapy was introduced to achieve a repopulation of the periodontal ligament fibroblasts.[11] Also, guided bone regeneration (GBR) is the best documented for the treatment of localized bone defects.[12] Advantages introduced for these methods such as no need to second surgical procedure to remove absorbable membrane.[13] The clinical and economic effects of bone defect treatments are staggering.[14] Several researches were done to produce biological materials for GBR and regrowth. Because of the unavailability of autogenous bone and the problems associated with surgery, non-autogenous, replacement material remains a treatment option.[15]

The emergence profile of the implant platform implies a bulky prosthesis, with consequent problems in oral hygiene and phonetics. Alternatively, total volumetric restoration of the alveolar ridge re-establishes the initial conjuration of the patient's bone and ideally permits prosthetic replacement of the missing teeth with their original shapes, sizes, and positions.[16] This goal, together with the endeavor to minimize surgical morbidity, has led to substantial research in the field of tissue engineering.[17] Although promising results have been reported, questions regarding security, cost-effectiveness, and reliability persist. Accordingly, at present, the gold standard treatment for cases of advanced atrophy is still autologous bone grafting.[18] This is the only method that can reliably provide the required source of osteogenic cells and osteoconductive and osteoinductive architecture for the reconstruction of the lost vertical and horizontal dimensions in these demanding cases.[19]

**Effects on Bone Regeneration**

Mostly, the complicated and multiple fractures due to trauma or age (mostly at hip joint, that is, femur head fractures) are supported with prosthetic implants for proper healing. These implants are comprised of various materials known as biomaterials. Nevertheless, after 12 years on average, the traditional implant failure is associated with biomaterial associated inflammation, loosening, wear or tears debris, osteolysis and autoimmune reactions.[20] These snags urge for the development of biomaterials with greater cytocompatibility and long-lasting life, with higher patient's quality of life. The role of nanotechnology and nanomaterials therefore becomes very pivotal. Various nanocomposites, materials and particles have been applied to mimic the growth of bone tissues, lower the autoimmune reactions and keep check on microbial infections.[21] Herein, we also mainly focus on the nanomaterials role in bone tissue repair, support, and maintenance. Organic bone tissue has various protein (collagen, fibronectin, laminin, and vitronectin) and water as soft hydrogel nanocomposites, whereas hydroxyapatite is hard inorganic components for the bone. The hydroxyapatite is present in nanocrystal line form which is 50 nm long and 3 nm thick, whereas the other proteins in the extracellular matrix are also at nanoscale size. This structural analogy allows the nanomaterials to interact easily with bone tissue and influence its functionality. Among the proposed nano-scaffolds for bone regeneration, Cerium (Ce-HA) based structures are among the leading candidates for bone tissue engineering. Similarly, a Mg- hydroxyapatite/collagen type I scaffold may also have great utility in bone regeneration.[22] Materials, at nanoscale, have been reported with better cell functionality than micro or macro scaled materials. The extracellular matrix provides scaffolds for the growth, proliferation and influence functionality of various cells. The nanoscale materials mimic the intrinsic and extrinsic pathways of osteocyte differentiation and mobility. Cells in various parts of the body exist in either two-dimensional (2D) or 3D environment, for example, stem cells in the intestinal crypts exists in 2D environment, whereas stem cells in bone marrow exist in 3D environment.[23] The nanomaterials may provide the desired environment for the proliferation of various cells in a bone niche. Similarly, the magnetic nanoparticles in addition to influence on osteocytes intrinsic pathways, may also act as mechanical stimulus that will help in the healing process. The silk fibroin-hydroxybutyl chitosan blended nanofibers successfully provided scaffold for the growth of porcine iliac endothelial cells. The nanofibers provided typical extracellular matrix to cells, where these cells formed endothelial monolayer with higher confluency.[24] Bioactivity is the ability for a material to mimic response in living system. The orthopedic bioactive materials should elicit the biological response at interface and build a strong bond between the material and bone tissue. Hence, the role of bioactivity is inevitable for biomedical applications of biomaterials. The bioactive materials for bone repair are mainly divided into osteoconductive and osteoproductive, depending upon the rate of implant and its tissue interaction.[25] The bioactive materials are mainly fabricated by either tailoring of bioactive composites and coatings or molecular surface tailoring. The later one is ideal for bone growth promoting factors, that is, BMPs. They are considered most important factors for the proliferation and growth of the bone tissue. The nanoarrays of gold has immobilizing effect on BMP-2, which allows the controlled release of BMP-2 that may have important role during the bone tissue repair via osteoblast.[25] Similarly, Tarpani *et al*.[26] used 130 nm silica ($SiO_2$) nanoparticles functionalized by amino group ($SiO_2$-N) and silver ($SiO_2$-Ag) nanoparticles for the growth of human BMSCs and observed good interaction between the silica nanoparticles and BMSCs, making it a strong candidate for future bone tissue engineering. Xia *et al*.[27] reported the highly interconnected microporous hydroxyapatite bio ceramic scaffolds whose surface was modified by nanosheet, nano-rod and micro-nano-hybrids. The materials not only promoted cell attachment, proliferation, spreading and osteogenic differentiation of adipose derived stem cells, but also enhanced the expression of angiogenic factors.

**Extraoral Donor Sites for Graft**

Good results have been reported with traditional extraoral donor sites such as the iliac crest, tibia, or calvarium.[28] Intraoral harvesting sites reduce these inconveniences while providing appropriate amounts of membranous bone, which seems to be less prone to resorption than grafts of endochondral origin. Bone blocks harvested from the mandibular symphysis and ascending ramus show adequate volumetric stability and provide effective mechanical support for early implant placement and immediate loading in the majority of cases. Moreover, research has shown that block coverage with particulated low-resorption-rate bone substitutes and resorbable barrier membranes reduces the rate of bone loss following mandibular bone block grafting.[16] In addition, the osteoconductive properties of particulated bone substitutes placed in the gaps between the grafted blocks, plus the cell guidance effect of membranes, contribute to the creation of a homogenous area of regenerated bone.[29]

**Iliac Graft**

Original treatments concentrated on the replacement of resorbed bone and involved autogenous iliac crest or rib onlay grafting to the inferior or superior borders of the mandible.[30] Reconstruction with iliac crest grafting was first reported in Europe and USA.[31] It is reported good initial results following the use of rib grafts. However, long-term follow-up studies of onlay techniques revealed significant graft resorption.[32] The present literature survey reports several donor sites for the bone graft, but the anterior iliac crest is the most commonly used. The anterior iliac crest can offer large quantities of bone and it is a rather safe donor site.[33] These factors make the anterior iliac crest the first choice for a grafting area. The literature survey identified three main techniques for bone reconstruction: onlay, sinus inlay, and inter-positional grafting. The resorption of the alveolar process produces three-dimensional changes in jaw relation, and the choice of the different reconstruction method can be made depending on the status for the actual patient.[34] Time-consuming surgeries that are usually done under general anesthesia, long recovery times, and substantial donor site morbidity, including the potential for donor site infection. Moreover, iliac crest and tibial grafts have the disadvantage of higher resorption risks because of the bone's endochondral origin.[35] The anterior iliac bone crest is the most commonly used, as a large quantity of bone is required for reconstruction of the atrophic maxilla. In the clinical studies, most of the planned implant positions had to be reconstructed regarding both height and width. The iliac bone can offer large quantities of bone and it is a rather safe donor site.[36] These parameters make the anterior iliac crest the first choice for a grafting site.[37]

**Reports**

Sjöström *et al*.[4] in a study on reconstruction of the atrophic edentulous maxilla with free iliac crest grafts and implants reported the anterior iliac crest was the donor site in 75% of the patients. The anterior iliac crest can offer large quantities of bone and it is a rather safe donor site.[38] These factors make the anterior iliac crest the first choice for a grafting area. The literature survey identified three main techniques for bone reconstruction: onlay, sinus inlay, and inter-positional grafting. The resorption of the alveolar process produces three-dimensional changes in jaw relation and the choice of the different reconstruction method can be made depending on the status for the actual patient.[39] The implant survival rate in the literature survey did not differ according to the grafting procedures, which was in line with the result in our clinical study with a nonsignificant difference between inter-positional and onlay/inlay bone grafting. These results indicate that, regardless of the resorption pattern in the maxilla, a treatment with a high rate of success can be performed.[40] Onlay grafts from the iliac crest were associated with the lowest survival rate (66.4%), followed by iliac bone sinus grafts with 70.5%.[41] Inferior quality of bone grafts from the iliac crest attributable to osteoporotic changes may thus have been one of the factors accounting for the significantly worse prognosis of implants in female patients.[41] Also, Sbordone *et al*.[42] autogenous iliac bone graft resorption in the human mandible obtained with 2-dimensional image analysis showed a resorption rate ranging from 44-50% after 5 years of follow-up. Even the limited amount of data in relation to the volumetric analysis of grafts have allowed various investigators to perceive an important remodelling phenomenon, although those studies that have verified this result had a short follow-up: for iliac crest onlay grafts, a mean resorption percentage of 47% in the first 6 months was recorded whereas, in a different survey, the degree of resorption ranged from 42-59% during the year after the procedure.[43] Placement of the iliac crest graft via a transcutaneous, submental approach, avoids communication with the oral cavity, thereby reducing the risk of infection.[34] In a study Guven,[44] used bone graft harvested from iliac crest was used for the reconstruction in the first case, followed by the application of 2 dental implants after 6 months. A free iliac bone graft and 2 dental implants were also used simultaneously with a 1-stage surgery in the second case; the patient had previously had a mandibular reconstruction with a rib graft. Free iliac bone graft is considered to be a favorable alternative for the maintenance of satisfactory functional and esthetic results in patients with severely atrophied alveolar ridges.[44] Cases with significant bone defects such as cleft palate, gunshot wounds, or severely resorbed mandibles, as presented in this article, require a large volume of bone grafts, preferably from the ilium or rib. Iliac bone transplants have been widely used for mandibular reconstruction. Due to their resistance to infection and large volume of bone that can be transferred, these grafts can be used to repair large bony defects and can also accept dental implants.[44] In a recent study, Paolo *et al*.[45] report the clinical outcome of an edentulous geriatric patient treated with iliac crest appositional autogenous bone block grafts and subsequent implant-supported bar-retained overdentures in a staged-approach. An adequate quality and quantity of newly formed bone allowed for ideal implant placement.[46] After the surgical procedures the healing proceeded uneventfully and no adverse events were encountered. The final prosthesis improved the oral-health quality of life of the patient resulting in a high satisfaction level as well as low morbidity. After a one-year follow-up period, no clinical and radiographic signs of inflammation and infection were reported in either jaw, stressing the reliability of this procedure even in geriatric patients.[47] Moses *et al*.[48] in a study on severely resorbed mandible treated with iliac crest autogenous bone graft and dental implants after 17-year follow-up reported the inter-foraminal region of the mandible was augmented anchoring it inferiorly to the residual mandibular basal bone. Implants later served as abutments for a fixed 12-unit implant-supported prosthesis. The patient was followed for 17 years, during which the mandibular prosthesis was replaced twice. Despite the initial questionable prognosis, oral rehabilitation was successful, with no detectable clinical signs of bone loss over the 17-year follow-up period. This clinical report describes the reconstruction of a severely atrophic maxilla with anterior iliac crest bone grafting using combined spinal epidural anesthesia. Neuraxial blockade techniques may be a useful alternative to eliminate general anesthesia related challenges of anterior iliac crest bone grafting procedures.[49] In a comparison study on long-term results of implants placed in iliac bone grafts or free flaps after tumor resection, Tommasato *et al*.[50] reported no significant difference in bone resorption before and after implant placement was found between iliac bone and free flaps grafts. Success and survival rates of implants had no significant differences between iliac bone and free flaps grafts. In a recent research Sakkas *et al*.[51] studied autogenous bone grafts in 279 patients and revealed 113 crista zygomatico-alveolaris grafts, 104 ramus mandible grafts, 11 symphysis grafts, 116 grafts from the anterior superior iliac crest, and 112 sinus lift augmentations with bone scrapes from the anterior facial wall had been performed. Two implants after iliac crest augmentation were lost within a period of 2 years after loading, concerning a total implant survival rate after 2 years of occlusal loading rate of 99.6% after autologous bone augmentation prior to implant insertion.

**Conclusion**

In conclusion the success of alveolar ridge rehabilitation using endo-osseous implants is directly related to bone quality and quantity. There are various alternative donor sites for bone reconstruction in the body: the ilium, rib, calvarium, tibia, maxilla, and mandible. Intraoral bone harvesting is usually accomplished under local anesthesia in a routine dental office setting or on a hospital outpatient basis.

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