REVIEW

Local Intraoral Autologous Bone Harvesting for Dental Implant Treatment: Alternative Sources and Criteria of Choice

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Abstract

Dental implants are established alternatives for replacing missing teeth. In case of alveolar bone resorption, implant placement may be prevented unless the volume of hard tissues is increased before or during implantation. Autologous bone graft is still regarded as the "gold standard" in alveolar reconstruction., but many factors may influence the final outcome. The success of intraoral bone grafts, in fact, depends, among other factors, on the choice of donor graft material as well as on how the material is handled. The evidence supporting the use of autogenous intramembranous bone with or without the use of barrier membranes is briefly reviewed. The rational of donor site choice is also presented. Advantages and disadvantages of different harvesting site are discussed. (Keio J Med 58 (1) : 24–28, March 2009)

***Keywords*: autologous bone graft, guided bone regeneration, ridge augmentation, oral implants**

Introduction

An adequate volume of bone is one of the factors critical to successful osseointegration and long-term retention of endosseous dental implants.[1,2] In situations where inadequate bone volumes exist, osseous ridge augmentation procedures often are necessary for predictable implant therapy. Although a number of different materials have been used for hard-tissue ridge augmentation during the past several decades, autogenous bone grafts are generally considered one of the more ideal augmentation materials.[3,4]

Clinical and Scientific Background

The choice of autogenous donor site is markedly influenced by two important considerations; namely, the quantity of bone required at the recipient site and the biologic qualities of the donor bone. Additionally, successful augmentation of the recipient site is influenced by the technical, intraoperative surgical manipulations employed. It is readily apparent that the quantity of bone required is a major factor in donor site selection. An extraoral donor site is often required for ridge augmentation in totally edentulous patients, for example, where ridge resorption may be extreme and extensive. A popular and reasonably safe extraoral site is the posterior iliac crest, which can yield relatively large bone volumes ranging 70-140cc.[5] Of course, the surgical convenience of iliac grafts is negated, in part, by the additional procedural requirements and attendant patient morbidity; such procedures are longer, often require the use of general anesthesia, increase the likelihood of intra- and postoperative complications, and can result in considerable postoperative pain. In contrast, ridge defects in partially edentulous patients often are less severe and more localized, necessitating a smaller quantity of bone. This allows greater flexibility in autogenous donor site selection and, in particular, makes highly feasible the use of intraoral donor sites. In such cases relatively modest bone

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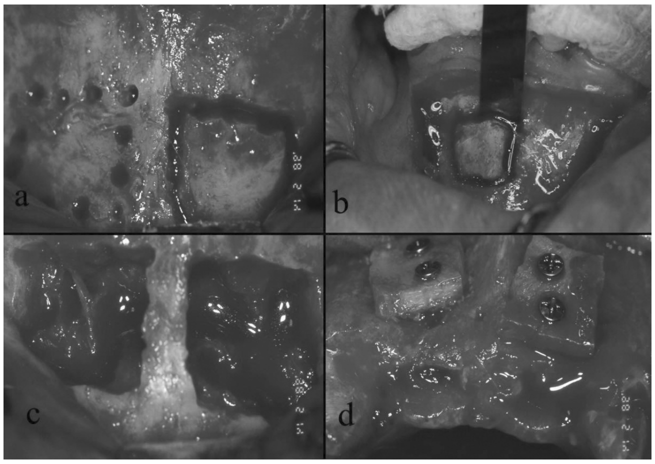

Fig. 1 Mandibular symphysis block harvesting: a- Outline of the graft. b- Mobilization of the block with a chisel. c- Area of symphysis after harvesting .d- Block grafting in place in the anterior maxilla in a 43-year old female.

Fig. 2 a- Buccal dehiscence. b- SPI implant (Waldenburg, Switzerland) placed. c- Bone harvested from retromolar area. d- Bone graft covering the implant before membrane placement.

volumes ranging 5-10cc from the mandibular symphysis, for example, may be adequate for ridge augmentation (**Fig. 1**).[5] Intraoral sites generally allow for shorter procedures, avoid the need for general anesthesia, and are associated with few complications and less postoperative discomfort. Somewhat less apparent than the bone quantity required, but no less important, are the biologic qualities of the transplanted bone. These include the bone's embryologic origin, morphology, cytological constituents, and biochemical composition of the extracellular matrix.[6] Although detailed review of each of these properties is beyond the scope of this report, further discussion of the embryologic origin of donor bone is warranted. The development of any given bone proceeds along one of the two general pathways, either endochondral or intramembranous ossification. In endochondral ossification, bone replaces a hyaline cartilage precursor. Long bones such as the tibia, fibula and femur as well as the iliac crest are formed in this way. Intramembranous ossification proceeds by direct mineralization of the organic matrix, without a cartilaginous intermediate. The bones of the craniofacial complex, with limited exceptions, form via intramembranous ossification. The calvaria, maxillary bones and mandibular body and ramus, in particular, are intramembranous; the mandibular condyles are exceptions because they are of endochondral origin.[7] The particular embryologic origin of donor bone is recognized as one factor in the success of bone transplantation procedures. From comparative studies of craniofacial reconstruction in animals and man, it appears that intramembranous grafts tend to maintain their volume whereas endochondral grafts undergo variable degrees of resorption over variable periods of time.[8,9,10] Thus, all other factors being equal, intramembranous rather than endochondral bone autografts may be preferred in head and neck/intraoral applications. From the preceding discussion we can appreciate the relative attractiveness of intraoral sites for the harvesting of donor bone. Such local harvesting is advantageous when bone volume demands are not prohibitively high because intraoral sites can serve as excellent, readily accessible sources of intramembranous bone. Within the mouth, the mandible tends to present more sources than the maxilla. As mentioned above, the mandibular symphysis is a very good donor site. The mandibular symphysis is almost invariably, however, not contiguous with the area to be augmented. This requires the involvement of a second surgical site. Clearly, an alternative mandibular donor site that is contiguous with the recipient area would obviate the need for an extra surgical site. Such alternative sources for local harvesting in the mandible can be evaluated by careful clinical and radiographic examinations of the patient. Tori and exostoses, which are common intraoral exophitic findings,[11] are suitable alternative bone sources. Retromolar and edentulous areas also can be accessed (**Fig. 2**). It is important to emphasize, albeit obvious, that the anatomical factor limiting bone harvesting in the posterior mandible is the mandibular canal and associated neurovascular elements. Presurgical treatment planning therefore should include appropriate anatomical determinations when such alternative harvesting is considered. Once harvested, the donor bone must be adapted to the recipient site. Several investigators have examined the various technical considerations in this regard.[12,13,14] These intraoperative considerations include the adequacy of donor bone volume, use of block grafts vs. ground bone, method of fixation, concomitant use of barrier membranes, and degree of

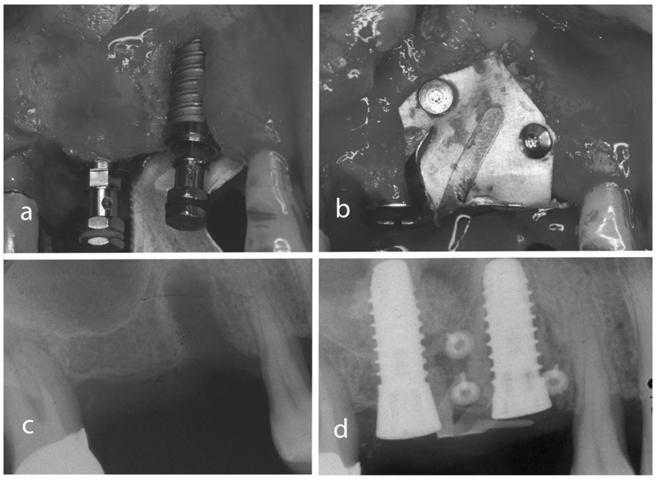

Fig. 3 a- Ridge defect with loss of buccal and lingual plate. b- Implant placement. c- Radiograph also showing sinus proximity. d- Post-operative radiograph showing sinus lift and ridge augmentation with bone graft harvested from retromolar area.

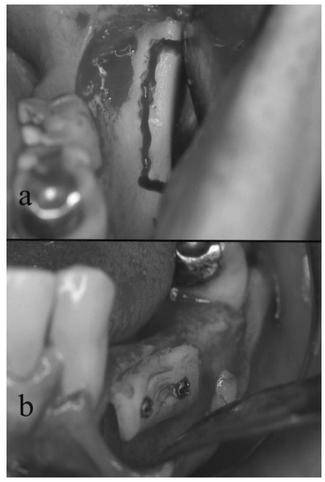

Fig. 4 Mandibular ramus block harvesting and horizontal ridge augmentation in the same quadrant in a 56-year old male. a- Outline of the block to be harvested from the ramus. b- Block graft in place.

flap coaption. In 1993, Buser and co-workers presented a technique for localized ridge augmentation using stainless steel pins to maintain space underneath a barrier membrane.[12] Subsequently, this group modified their technique by adding corticocancellous bone grafts harvested from the retromolar area.[13] Bone chips harvested from contiguous areas were also packed into the augmentation site. The rationale for using autologous bone with barrier membranes was that the bone had both space-maintaining and bone growth promoting properties. The benefit of the combined use of bone grafts and membranes was confirmed by Jensen *et al*. who found, using a canine model, less resorption of autologous block grafts when membranes were used (**Fig. 3**).[14]

Discussion and Criteria of Choice

Successful treatment of localized ridge defects can be achieved with autologous intraoral bone transplant with and without combined guided bone regeneration.[15−19] The volume of bone required can be small enough to allow harvesting from intraoral sites. Intraoral bone donor sites provide convenient surgical access, decreased procedure time, and lower morbidity.[20] In addition, the donor and recipient sites are comprised of bone having the same embryologic origin (i.e., intramembranous). There seems to be some difference in treatment outcomes, intraorally, between endochondral and intraoral donor bone. Endochondral grafts have been widely used in oral and maxillofacial reconstructions, with and without osseointegrated implants. Typical donor sites are the anterior and posterior iliac crest, the rib,[5] and the tibia.[21,22] However, endochondral bone grafts are associated with delayed, sometimes dramatic resorption[10] and the associated implant success rates range 25-86%.[10,23−25] As a consequence, intramembranous bone tends to be more preferred in craniofacial reconstructions, again with or without implant placement.[26−37] Intramembranous, mandibular symphysis grafts have shown less delayed resorption and less morbidity than extraoral endochondral grafts.[36,37] The placement of implants in areas grafted with chin bone has been documented.[32−35] In particular, Jensen and Sindet-Pedersen[32] reported a 94% success rate of 107 implant fixtures in 26 patients grafted with chin bone, following up to 32 months. Other locations in the mandible also have been used to obtain intramembranous bone; these include the retromolar region (**Fig. 2**),[13] the ramus[20,38] (**Fig. 4**) and tori.[39−40] Tori mandibularis[11] when present may represent an alternative or additional source of grafting tissue. Postoperative morbidity, mainly temporary paresthesia, differs among the sites used for harvesting: the chin ranged from 10% to 50%,[41,42] whereas the mandibular ramus ranged from 0% to 5%.[41,42] Thus, the mandibular ramus has some advantages when compared to the mental symphisis as a possible donor site: the quality of bone is similar, the quantity may be higher, and the risk of neural damage is lower.[43] Survival and success rates of implants placed in reconstructed jaws are, on average, lower than those of implants placed in native bone. This appears to be particularly true in cases where extensive reconstructions were performed, although it has to be considered that many of the implants failures occurred in relatively few patients.[43] The success rates of implant therapy using these alternative sources for local harvesting in the mandible have been less well documented. Nevertheless, a hierarchy of clinical preferences can therefore be established for ridge augmentation in the partially edentulous patient using autogenous bone. First, intraoral intramembranous donor bone is often preferred over extraoral bone of either intramembranous (ex. calvaria) or endochondral (ex. iliac crest) origin. Second, mandibular donor bone tends to be preferred over maxillary bone. Third, when feasible, donor bone that is contiguous with the recipient site is preferred over intraoral bone from a second distinct location. Fourth, when the transplanted bone is insufficient, additional chips of bone can be collected and packed to achieve a ridge with the desired size and shape. Fifth, the concomitant use of a barrier membrane, in accordance with the principles of Guided Tissue Regeneration, is more preferred than bone transplants without membranes.

Conclusion

The use of appropriate surgical techniques, backed by sound knowledge of bone biology and knowledge of possible alternatives for intra-oral bone harvesting optimizes ridge augmentation procedures.

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