Influence of Bed Preparation on the Incorporation of Autogenous Bone Grafts: A Study in Dogs

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To study the influence of bed preparation on the incorporation of autogenous bone grafts in mandibles, 6 dogs with 3 different types of receptor bed were used: cortical, perforated, and decorticated. After 45 and 90 days, the animals were sacrificed and block sections of grafted and adjacent bone were removed. The specimens were prepared and stained with hematoxylin and eosin and Masson's trichromic. The autogenous bone grafts were integrated with the receptor bed, mainly in the perforated and decorticated groups. The poorest results were found in the cortical group. (Int J Oral Maxillofac Implants 2000;15:565–570)

Key words: *alveolar ridge augmentation, bone transplantation*

The edentulous mandible generally demonstrates progressive atrophy to 50% of its original volume[1,2] and in severe cases, this reduction involves the alveolar crest and mandibular basal bone.[3,4] Ulm et al[5] reported that the mandible lost 60% of its original osseous substance during progressive atrophy and most of the loss occurred in the early period of the process. The areas with the most loss are the premolar and molar regions. In this resorption process, cortical and cancellous osseous substances are frequently lost. It was observed that the cancellous bone of the severely atrophied mandible is marked by a significant increase in density, mainly in the intermental region. Murphy[6] has affirmed that the contour and structure of the edentulous mandible are different from those of the dentate mandible, with a reduction in residual alveolar ridge height and width. At the cellular and molecular levels, there is reduced bone mineral content, and osteoporotic changes are common.

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The clinical success and longevity of endosteal dental implants are controlled largely by the health of the surrounding crestal region of bone and soft tissue,[7] and in partially edentulous patients, autogenous bone grafting has been necessary to increase the width of the residual alveolar ridge. In 1980, Breine and Brånemark[8] reported the first information about endosseous implants placed in grafted bone as a part of the reconstructive procedure. Since then, numerous articles have been published presenting a variety of procedures utilizing different types of implants, bone grafts, and other grafting materials for oral and craniofacial reconstruction.[9]

Collins et al[10] have suggested that when autogenous grafting becomes necessary to provide adequate bone volume for implants, there are several distinct and equally important requirements for success: *(1)* alignment, *(2)* the team approach, *(3)* anatomic replacement, *(4)* intimate interfacial fit, *(5)* rigid fixation, *(6)* solid nongraft anchorage of the implant in native bone, and *(7)* a minimum of 1. 5 mm of graft bone covering the restoration without pressure. While the clinical concerns about autogenous bone grafts are well known, the biologic responses remain somewhat mysterious, mainly in cortical areas such as the posterior mandible.[8] The objective of the present study was to analyze the histomorphology of autogenous bone grafts in cortical, perforated, and decorticated beds in dogs.

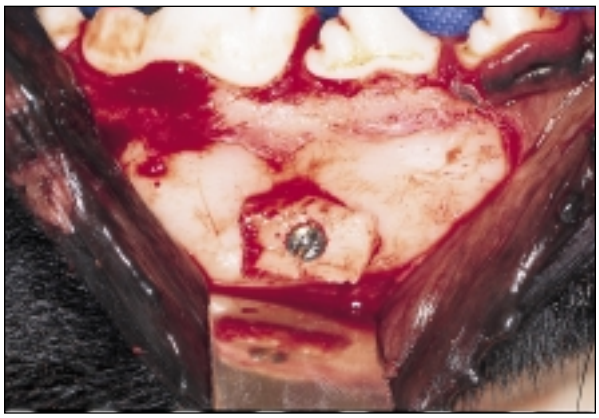

Fig 1a Bone graft without bed preparation (cortical).

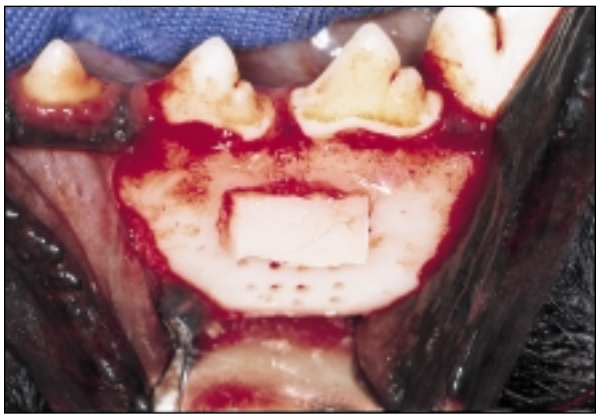

Fig 1b Bone graft in perforated bed.

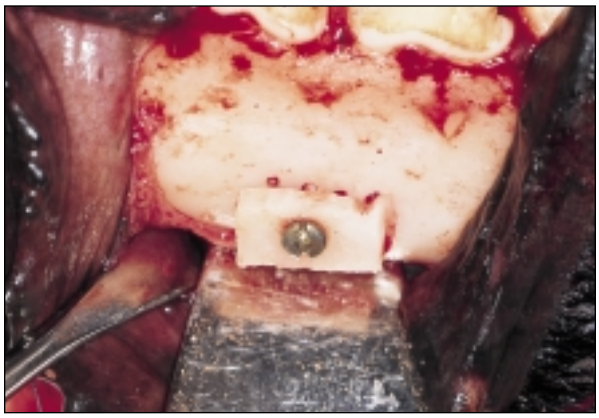

Fig 1c Bone graft fixed with a screw in perforated bed.

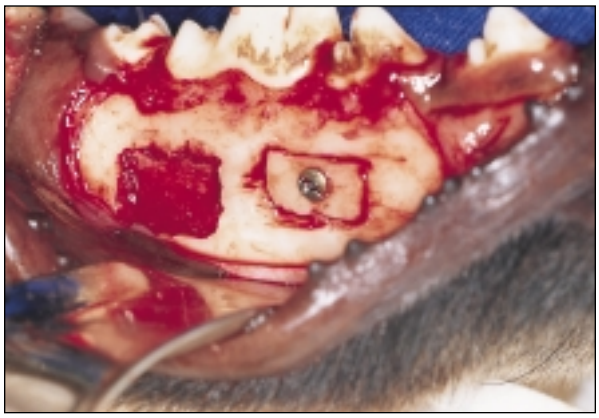

Fig 1d Bone graft in decorticated bed.

MATERIALS AND METHODS

Animals and Care

Six adult dogs in good systemic health were used in this study. Prior to surgery, the animals were given standard dry dog food ad libitum. Before surgery, the animals' teeth were scaled and cleaned. After surgery, the animals were given 1.2 million IU benzetacil (benzylpenicillin benzatin). All animals remained healthy throughout the duration of the study.

Surgical Treatment

Prior to surgery, the dogs were anesthetized with thionembutal sodium (30 mg/kg intravenously). Full-thickness mucoperiosteal flaps were reflected and a corticocancellous graft was removed from the posterior mandible and fixed with screws in 3 different receptor beds: cortical, perforated, and decorticated (n = 2 for each type of receptor bed and each time period) (Figs 1a to 1d). The flaps were closed with interrupted sutures.

Specimen Preparation

At 45 and 90 days postsurgery, 3 animals were sacrificed with an overdose of anesthetic solution, and block sections of grafts and adjacent bone were removed and fixed in 10% formalin. Following fixation, routine laboratory procedures were performed, the specimens were embedded in paraffin, and histologic serial sections were prepared and stained with hematoxylin and eosin and Masson's trichromic.

RESULTS

Specimens at 45 Days

In the cortical sites, it was possible to observe some areas of osseous graft integration with the receptor bed (Fig 2a), but in the same animal, there were areas of connective tissue interposed between the graft and the receptor bed (Fig 2b). Clinically, it was possible to observe resorption of the bone graft in this group (Fig 2c). It was also possible to identify inflammatory cells surrounding the graft.

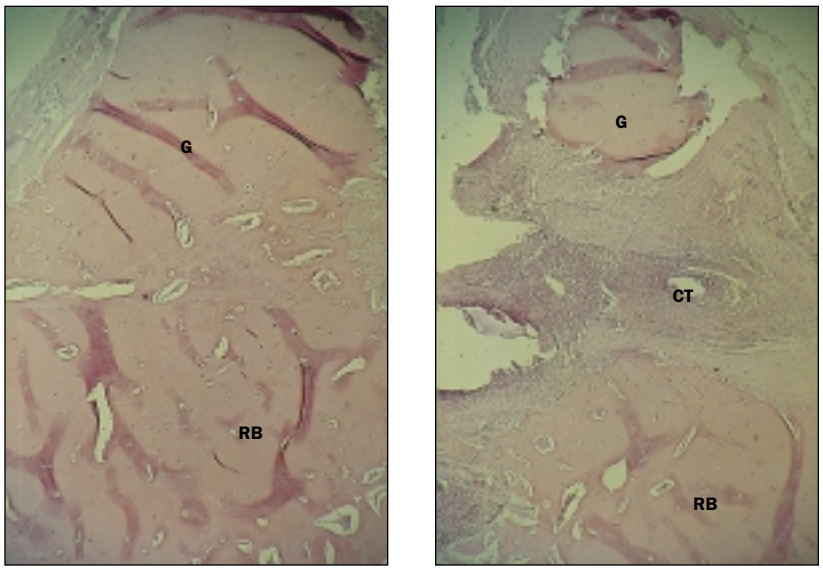

Fig 2a *(Left)* Cortical bed at 45 days. Areas of osseous graft (G) integration with the receptor bed (RB) can be seen (hematoxylin and eosin; magnification ×25).

Fig 2b *(Right)* Cortical bed at 45 days. Connective tissue (CT) can be seen between the graft (G) and the receptor bed (RB) (hematoxylin and eosin; magnification ×25).

In specimens with perforated beds, there were areas of integration with the graft and the bed (Fig 3a) in all animals. In this period it was possible to observe immature osseous tissue with large trabecular spaces (Fig 3b) and some areas of connective tissue in newly formed osseous tissue (Fig 3c).

In the decorticated specimens, areas of total integration of the graft and the bed were observed (Figs 4a and 4b). In one specimen, part of the graft was separated from the osseous bed (Fig 4c). The grafts remained vital in the perforated and decorticated groups.

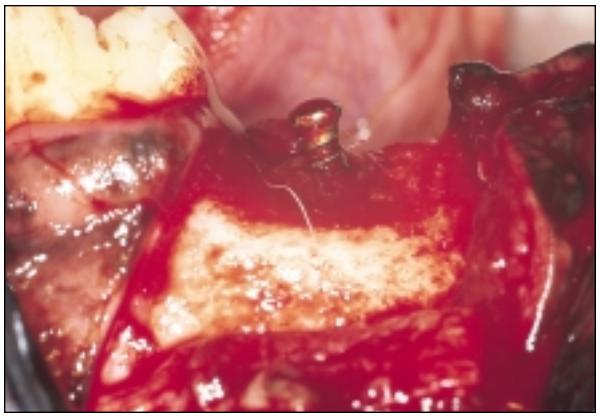

Fig 2c Resorption of bone graft in cortical bed at 45 days.

Specimens at 90 Days

Histologic observations of the cortical and perforated sites continued the pattern observed in the 45-day specimens of graft integration in some specimens or connective tissue covering the bone graft (Fig 5a). In the perforated bed specimens it was possible to observe some projections of osseous tissue in the direction of the graft (Fig 5b). The sequence of sections suggests that the peripheral sections had more connective tissue between the graft and the osseous bed, probably because the graft did not have perfect adaptation with the receptor bed. In the decorticated group, the histologic sections showed integration and vitality of the osseous graft (Fig 5c).

DISCUSSION

The application of mandibular bone grafts in atrophic areas improves local conditions for fixation of endosseous dental implants, and predictable results are generally more likely. In this study, autogenous bone grafts were removed from the molar region of the mandible and placed in the premolar region using 3 different receptor beds: cortical, perforated, and decorticated. A mandibular bone graft was used because of its embryologic origin (membranous bone). Experimental evidence suggests that grafts from membranous bone show less resorption than endochondral bone.[11–13] These observations are explained by Hammack and Ennerking[14] and Kusiak et al,[15] who noted that although cancellous grafts revascularize more rapidly than cortical grafts, cortical membranous grafts revascularize more rapidly than endochondral bone grafts, with a thicker cancellous component. This early revascularization of

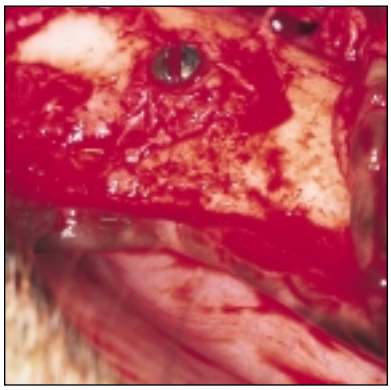

Fig 3a Incorporation of bone graft in perforated bed at 45 days.

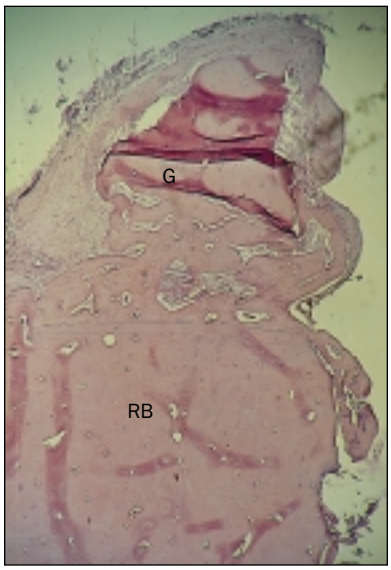

Fig 3b Perforated bed at 45 days. Areas of osseous graft (G) integration with the receptor bed (RB) can be seen (hematoxylin and eosin; magnification ×25).

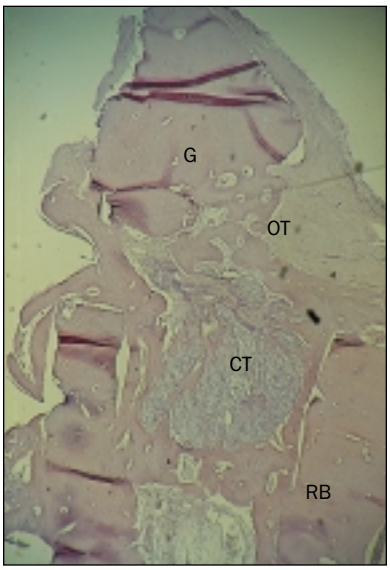

Fig 3c Perforated bed (RB) at 45 days. Connective tissue (CT) is interposed between the graft (G) and newly formed osseous tissue (OT) (hematoxylin and eosin; magnification ×25).

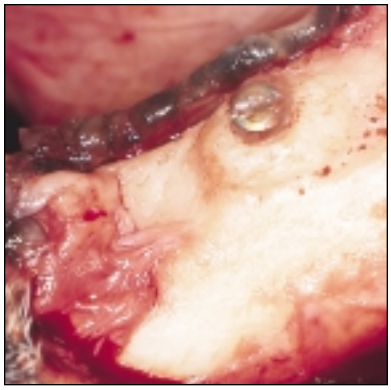

Fig 4a Incorporation of bone graft in decorticated bed at 45 days.

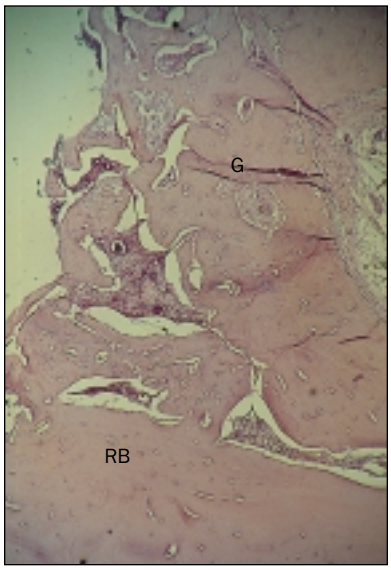

Fig 4b Decorticated bed at 45 days. Areas of osseous graft (G) integration with the receptor bed (RB) can be seen (hematoxylin and eosin; magnification ×25).

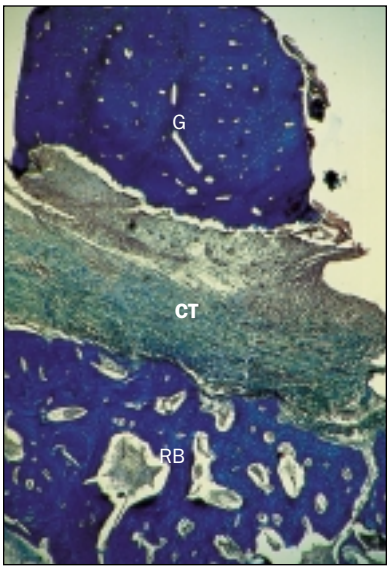

Fig 4c Decorticated bed at 45 days. The osseous graft (G) is not integrated, with connective tissue (CT) interposed between the graft and the receptor bed (RB) (Masson's trichromic; magnification ×25).

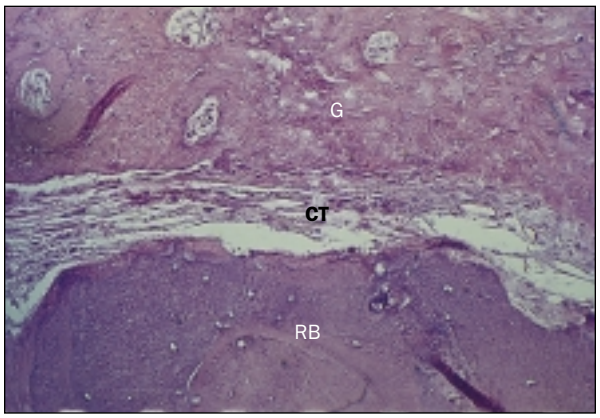

Fig 5a Cortical bed at 90 days. Connective tissue (CT) is seen between the graft (G) and the receptor bed (RB) (hematoxylin and eosin; magnification ×63).

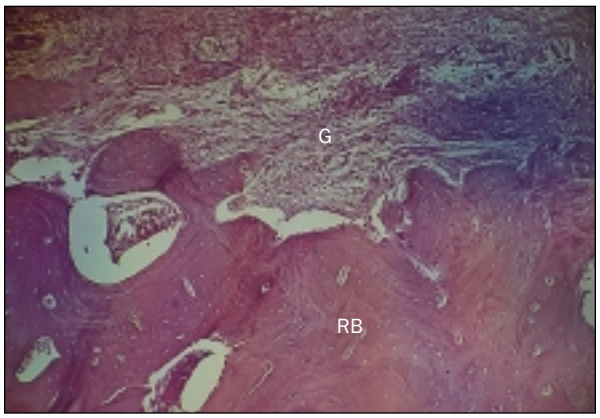

Fig 5b Perforated bed at 90 days. Osseous graft (G) is integrated with the receptor bed (RB) (hematoxylin and eosin; magnification ×63).

membranous bone grafts in the perforated and decorticated samples offers a possible explanation for the improved maintenance of graft volume. Another hypothesis is that bone of ectomesenchymal origin, such as that in the mandible, has better potential for incorporation in the maxillofacial region because of a biochemical similarity with the protocollagen of the donor and the recipient bone.[16,17]

Different results were obtained by Breine and Brånemark,[8] who conducted clinical studies on 2 types of grafts obtained from the iliac crest: bone from chips placed around the implants, and preformed bone grafts placed simultaneously with implants. The authors observed that the bone chips were resorbed in 1 year, and 50% of the implants fixed with preformed bone grafts were lost. This work suggests that bone grafts must be integrated with the bed before fixation of implants, and that bone grafts obtained from the iliac crest probably resorb more because of their endochondral origin.

The results obtained in this study demonstrated that autogenous bone grafts were integrated with the receptor bed, mainly in the perforated and decorticated groups. It probably happened because these sites revascularized rapidly, maintaining vitality of the grafts. The poorest results were found in the cortical group, which showed connective tissue between the graft and the receptor bed. These features may be explained by the high density of mandibular bone and deficient revascularization of the bone graft. The interposition of connective tissue between the bone graft and the bone bed could also be the result of lack of graft adaptation to the receptor bed.

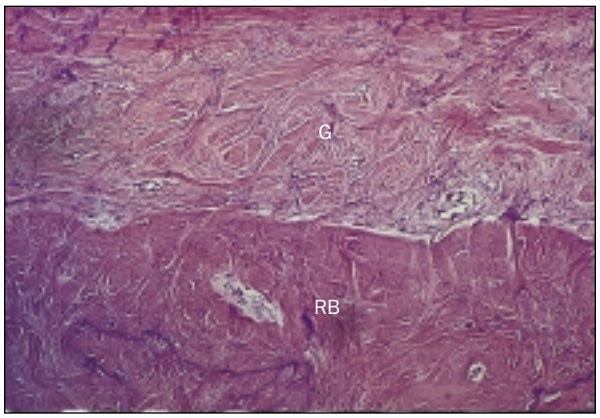

Fig 5c Decorticated bed at 90 days. The bone graft (G) is integrated with the receptor bed (RB) (hematoxylin and eosin; magnification ×63).

CONCLUSIONS

Within the experimental conditions of this study it was possible to conclude that:

1. Bone graft incorporation differed with the type of bed preparation.
2. In the specimens without preparation of the receptor bed, the interposition of connective tissue and partial resorption of the bone grafts occurred more frequently.
3. When the receptor bed was prepared with perforation or decortication, integration of the bone graft and maintenance of graft volume were seen.

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