Barrier membranes used for ridge augmentation: is there an optimal pore size?

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Abstract

PURPOSE: To identify the optimal pore size of barrier membranes for successful alveolar ridge reconstruction procedures, to determine if cortical perforations have any effect on bone regeneration, and to reiterate that bone graft containment is an important parameter for successful regeneration.

MATERIALS AND METHODS: This was a prospective, randomized, controlled study performed on hound dogs. Corticocancellous tibial bone grafting was performed to the lateral border of the mandible and protected with barrier membranes (meshes). The experiment analyzed three different pore sized meshes, compared with controls without the mesh. Two meshes (macroporous and microporous) were made of titanium, and one was a resorbable mesh. Meshes were preformed into the shape of a cube with one face open. Each side of the cube measured approximately 10 mm. Cubes were open-faced on one side, to facilitate packing of the graft material. The dogs received bilateral ramus grafts. Cortical perforations were created on the left ramus of all the dogs and compared with the right side, which did not have perforations. The dogs were randomly divided into 3 groups and sacrificed at intervals of 1, 2, and 4 months. Before sacrifice, all dogs received
2 doses of tetracycline as a marker for new bone formation. Histomorphometry was performed by using Bioquant image-analysis software. Areas of new bone and soft tissue were measured. The rate of mineral apposition was also calculated. All values obtained via histomorphometry were statistically analyzed with a t test.

RESULTS: Thirty-one experimental sites were evaluated. The amount of new bone growth into the macroporous mesh was significantly higher than in the other groups. The mean area of new bone formation in large and small meshes was 66.26 +/- 13.78 mm(2) and 52.82 +/- 24.75 mm(2), respectively. In the resorbable mesh group, the mean area of new bone formed was 46.76 +/- 21.22 mm(2). The amount of new bone formed in the control group was 29.80 +/- 9.35 mm(2). There was no significant difference in amount of bone formation between left and right sides (P = .3172). Resorbable meshes had significant soft tissue ingrowth (23.47 mm(2)) compared with macroporous mesh (16.96 mm(2)) and microporous mesh (22.29 mm(2)). Controls had the least amount of soft tissue ingrowth (9.41 mm(2)). Mineral apposition rate was found to be higher in the resorbable group (2.41 microm/day), and the rate was lowest (1.09 microm/day) in the large pore mesh group.

CONCLUSION: Macroporous membranes facilitated greater bone regeneration compared with microporous and resorbable membranes. Macroporous mesh also prevented significant soft tissue ingrowth compared with other meshes. Containment of a bone graft is the most critical parameter in successful bone regeneration. Cortical perforations did not have any effect on the quantity of regenerated bone. Further research should be directed toward identifying a critical pore size and manufacturing a reliable mesh that would prevent excessive soft tissue ingrowth in ridge augmentation procedures.

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