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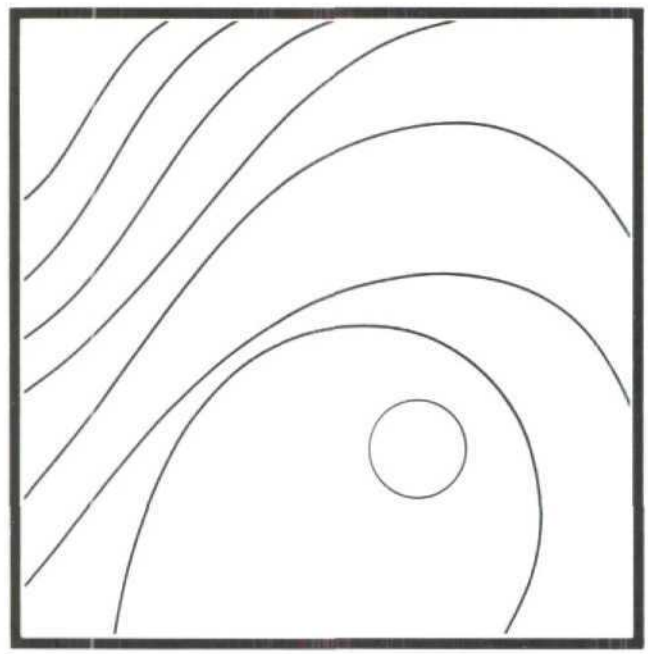

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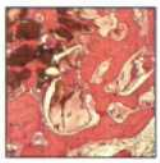
Histologic Evaluation of Sinus Elevation Procedure: A Clinical Report



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A histologic assay of the grafting material associated with the sinus elevation procedure would provide insight into the quality and quantity of vital bone at the implant-bone interface. This case report documented for the first time the sequential healing process of a sinus graft in the same patient at 4, 8, 12, and 20 months. Histology of trephine-obtained core samples showed that in a sinus grafted with a mixture of xenograft (80%) and autograft (20%), 12 to 20 months was required for remodeling to vital bone. The study also demonstrated that a significant amount of vital, mature bone was generated by this procedure. Quantification of the resulting bone and comparison with other grafting techniques should be the next phase of continuing research efforts. (Int J Periodont Rest Dent 1996;16:47–51.)

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The sinus elevation and subantral augmentation procedure first introduced by Tatum[1] and later modified by Wood and Moore[2] has seen a marked increase in clinical usage. In fact, it has become one of the most common methods for increasing vertical bone height for implant placement in the posterior atrophic maxilla. This growth has been encouraged by high success rates reported in the literature[3] and by anecdotal information supplied by leading clinicians. In almost all cases, the reported success was related to apparent rigid fixation (stability) of the implants placed in the augmented sinus. Only recently[4] has there been a histologic comparison (dog model) of the results achieved with different grafting materials.

While the success is impressive, there are many variables included in this type of reporting which can make it difficult for clinicians to duplicate these results. These variables include but are not limited to the type

of bone grafting material utilized, an immediate or delayed placement procedure, the type of implant, the surgical and prosthetic protocols, and the effects of postsurgical and prosthetic loading.[5] Successful osseointegration is defined by events that occur at the implant–bone interface. Consequently, it is reasonable to assume that the success of the sinus elevation procedure is best defined and understood by the histologic status of the bone at that interface. Using the histologic definition, a successful sinus elevation procedure is one that provides the maximum quantity and quality of vital bone to take part in the process of osseointegration.

Use of the histologic definition precludes many of the variables associated with the sinus lift procedure, and may allow informative examination of the key variables that lead to the formation of vital bone in the sinus cavity. The current report describes the grafting procedure utilized and temporal histologic findings documenting the healing response over a 20-month time period.

Case report

A 65-year-old man in good health presented with an atrophic maxilla with all posterior teeth missing. In preparation for implants, a bilateral sinus elevation procedure was performed using a combination of xenogenous and autogenous grafting materials. After allowing 4 months for graft healing, seven one-stage implants were placed in the sinus. At time of implant placement (4 months) and at 8, 12, and 20 months, horizontal bone cores were harvested with a trephine. All the cores were decalcified, sectioned, and stained with hematoxylin-eosin for histologic evaluation.

Grafting material

Many consider autologous marrow or corticocancellous grafts obtained from the hip to be the "gold standard" of grafting material for the sinus elevation procedure.[6] The required hospitalization and increased morbidity of the extraoral procedure makes a completely intraoral procedure that achieves similar results advantageous. Moy et al[7] have reported almost 60% bone in the sinus with the utilization of an autogenous graft harvested from the chin.

In a paper on the mechanism of the anorganic bovine matrix (xenograft), Cheung and Tofe[8] showed that the xenograft has the qualities of the autograft matrix, and consequently may be suitable as a graft material in sinus elevation procedures. In an effort to minimize the requirement for intraoral sourcing, autogenous bone harvested from tuberosities was combined with commercially available xenograft material. The following formulation (by volume) was prepared for grafting: 40% 250 to 420 mm of anorganic bovine matrix (OsteoGraf/N-300, CeraMed), 40% 420 to 1000 mm of anorganic bovine matrix (OsteoGraf/N-700), and 20% autogenous bone harvested from the tuberosities.

The formulation of the autogenous bone and marrow with the anorganic bovine matrix[9] provided the basis for the findings seen in this study.

Histologic findings

Focusing on histology allowed an assessment of the osseous changes that occurred over time during the healing phase following the use of a combination of xenograft and autograft for a sinus elevation procedure.

This study in the same patient at different stages of the 20-month healing period allowed, for the first time, a temporal evaluation of the bone turnover process. Figures 1a to 1d depict the sequential histologic events involved in the turnover/replacement (remodeling) of the anorganic bovine (xenograft) bone matrix and vital autogenous bone in the maxillary sinus. Figure 1a illustrates that the nonvital bone present at 4 months is the remnant of the original autograft, with only a very small percentage of vital bone formed at this time. The 8-month (Fig 1b) and 12-month (Fig 1c) intervals show increasing vascularity and vital bone content, with a concurrent decrease in residual autograft and xenograft material. It is interesting to note the increased presence of osteoclastic activity, especially in the 12-month section. The 20-month section (Fig 1d) shows an increase in volume and maturation of vital bone, a complete lack of xenograft, and the presence of a fatty, mature, and relatively avascular marrow.

Fig 1a *Histologic section at 4 months. Bone* (solid arrows) *and xenograft* (outlined arrows) *are evident. Note that most of the bone is nonvital, as evidenced by empty lacunae (hematoxylin-eosin stain; original magnification × 33).*

Fig 1b *Histologic section at 8 months. Bone* (solid arrows) *has increased, xenograft* (outline arrows) *has decreased. Note that the cells in lacunae indicates that all of the bone is vital (hematoxylin-eosin stain; original magnification × 33).*

Fig 1c *Histologic section at 12 months. Bone volume has increased, xenograft volume has decreased. Note that the marrow* (solid arrows) *is vascular (hematoxylin-eosin stain; original magnification × 33).*

Fig 1d *Histologic section at 20 months. Bone volume and density have increased, and the xenograft was completely resorbed. Note that the marrow* (solid arrow) *is fatty and mature (hematoxylin-eosin stain; original magnification × 33).*

Discussion

The temporal histology presented indicates that, in this case, remodeling of the xenograft (OsteoGraf/N) appears to have occurred during the 12- to 20-month interval. Visually, the percentage of bone seen in the later slides is significant. It is also evident that by 12 months all remaining nonvital autograft has been replaced or resorbed. The time required for resorption of the xenograft (12 to 20 months) seems to favor the delayed approach to implant placement, because minimal bone is available for primary stabilization before this time. Further study is necessary to determine if the responses seen in this case are representative with use of a composite xenograft/autograft. Also, information is needed to ascertain the role of the autogenous bone graft material, and whether variation in the quantitative amount of each material may also alter the results. Finally, variables such as host response, graft materials utilized, technique employed, and skill of the operator may alter the results of the procedure.

Conclusion

In this patient, the combination of a xenograft with autogenous bone from intraoral sources was histologically shown to convert to vital bone over a 12- to 20-month period. The replacement of the xenograft material is not a short-term event and, like nonvital human bone, takes close to 2 years to be replaced. Further research with a controlled method of measuring vital bone is indicated to determine the effect of known variables to optimize the success rate of this procedure.

Acknowledgments

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