

Teeth may be lost because of trauma, caries, periodontal disease, congenital defects, and iatrogenic treatment. Tooth loss has a negative impact on masticatory function, esthetics, and self-image. After dental extractions, the residual alveolar bone undergoes a period of accelerated resorption for about 10 weeks, followed by a slower, but progressive resorption thereafter. Yet maintenance of the dentition does not guarantee immunity from bone loss. Periodontal attachment and bone loss occurs over time, except on those teeth free of bacterial plaque.

Fixed partial dentures (FPDs), removable partial dentures (RPDs), complete dentures (CDs), and implant-supported dentures can replace missing teeth comfortably and esthetically, but it is not certain what effect these prostheses have on the residual ridge. The use of implant-supported fixed prosthesis to restore missing teeth in partially or completely edentulous jaws seems to be the best means of preserving residual alveolar bone. (J Prosthet Dent 1998;80:362-6.)

**Clinical implications**

After dental extractions, the residual alveolar bone undergoes a period of accelerated resorption, followed by minimal yet progressive bone loss. The use of implant-supported fixed prosthesis to restore missing teeth in the partially or completely edentulous jaw is the recommended treatment choice to preserve residual alveolar bone.

**Statement of problem.** Complete, fixed partial, removable partial, and implant-supported dentures have been used to comfortably and esthetically replace missing teeth. However, it is not certain what effect these prostheses have on the residual ridge.

**Purpose.** This article compares various prosthetic treatments to restore completely and partially edentulous mouths for their ability to preserve residual alveolar bone.

**Material and methods.** A review of the literature was performed to discuss the effect of tooth replacement on residual alveolar bone.

**Results.** The literature seems to indicate that the presence of a dental prosthesis affects the size and form of the residual alveolar ridge and bone.

**Conclusion.** An implant-supported fixed prosthesis to restore missing teeth in partially or completely edentulous jaws seems to be the best means of preserving residual alveolar bone. (J Prosthet Dent 1998;80:362-6.)

Bone loss adjacent to endosseous implants, particularly during the healing and remodeling periods, has been documented. Placement of implants requires modification of bony topography; however, dissection of the mucoperiosteum when inserting the implant also results in bone resorption. Occlusal forces placed on implants, along with the presence of microflora, are the probable causes of marginal bone loss surrounding implants. The distribution of forces placed on implants will vary depending on the design of the prosthesis. Parafunctional occlusal forces have been associated with bone loss of greater than 1 mm per year adjacent to implants. In addition, greater marginal bone loss has been documented around anterior compared with posterior implants when supporting long posterior cantilevers. Marginal bone loss adjacent to implants has been associated with poor oral hygiene, at least in those persons who smoke. However, no association has been found between failed implants and periodontal, gingival, and plaque indices. Whether the accumulation of plaque around an implant results in bone loss, as in periodontitis, remains to be seen.

The purpose of this article is to compare the prosthodontic treatment modalities used to restore completely and partially edentulous patients and their ability to preserve residual alveolar bone.
that edentulous patients wearing dentures had, on average, smaller residual ridges than those not wearing dentures. Increased residual ridge resorption seen in denture wearers was attributed to pressure from the prostheses. Dentures may help to preserve the buccal plate of bone when inserted immediately after teeth are extracted, at least during the first 20 weeks after extraction, and possibly for up to 3 years. The horizontal dimension (cross-section) of the residual ridge is maintained to some extent, yet the vertical dimension undergoes resorption, especially in the mandible. Overall, progressive and irreversible alveolar bone loss results from the extraction of teeth, regardless of how soon after extraction a denture is provided.

Loss of alveolar bone from an edentulous ridge is more pronounced in the mandible than the maxilla, particularly in the early (3 months) postextraction period. The mean reduction in anterior maxillary vertical radiographic bone height during the first year after extraction has varied between 2 and 4 mm, compared with 4 to 6 mm in the mandible. In a follow-up study of edentulous patients over an average of 2.5 years, Atwood and Coy found a mean annual bone loss of 0.4 mm in the mandible and 0.1 mm in the maxilla. Even though Tallgren et al. documented a slightly lower mean annual bone loss over 25 years (0.20 mm in the mandible and 0.05 mm in the maxilla), the same 4-fold difference in resorption remained between the jaws. The differential residual ridge resorption seen between the maxilla and the mandible has been attributed to the mandible providing a smaller surface area of support for the denture.

The alveolar bone in the posterior part of the mandible is slightly more at risk to resorption, with an average vertical bone loss over a 5-year period of 1.5 mm in the incisor region, 1.6 mm in the premolar region, and 1.6 mm for the molar region. The difference in occlusal forces, between the anterior region where lighter forces for incising food occurs compared with the posterior region where heavier forces are required for triturating, may be responsible. For the maxilla, the extent of alveolar bone resorption seems to be a function of composition of the opposing dentition. Patients with most of their mandibular teeth experience less resorption of the maxillary anterior residual ridge over 5 years than patients with only mandibular anterior teeth. The anterior maxilla may experience increased compressive forces when solely opposed by mandibular anterior teeth. This phenomenon, often called the "combination" syndrome, has yet to be scientifically validated. In the situation of complete maxillary and mandibular dentures, the decreased stability of mandibular dentures compared with natural teeth may place increased lateral forces on the opposing maxillary denture that may accelerate residual ridge resorption.

ParafUNCTIONAL forces may accelerate bone loss of edentulous ridges and have been associated with soreness of the denture-bearing mucosa. Significantly greater bone loss after 1 year has been reported in the anterior mandible for patients wearing their dentures day and night compared with wearing dentures only during the day.

Even though the rate of resorption varies between persons and within a given person over time, those persons with higher initial rates of bone resorption tend to lose more bone in the future. Overall, bone loss in the edentulous maxilla and mandible shows marked variation between different sites independent of age and sex, preextraction periodontal status, or height of the alveolar ridge.

OVERDENTURES

Overdentures are designed to distribute the masticatory load between the edentulous ridge and the abutments. The overdenture transfers occlusal forces to the alveolar bone through the periodontal ligament of the retained tooth roots. Proprioceptive feedback, from the periodontal ligament to the muscles of mastication, may act to prevent occlusal overload and thereby prevent bone resorption because of excessive forces. The short-term and long-term preservation of alveolar bone has been documented not only adjacent to the overdenture abutments but also adjacent to the edentulous ridges. A comparison of immediate conventional dentures and immediate overdentures found half as much bone loss (0.9 mm compared with 1.8 mm) in the anterior mandible over the first year in the overdenture group; surprisingly, the bone loss was also slowed in the posterior mandible. The increased stability that resulted from the use of overdentures may limit lateral forces placed on residual bone. Crum and Rooney measured a mean vertical bone loss in the anterior of the mandible of 5.2 mm after 5 years for immediate dentures compared with 0.6 mm for immediate overdentures. Similarly, bone loss adjacent to overdenture abutment roots in the maxilla, especially for dentures opposing mandibular anterior teeth, has also been documented.

REMOVABLE PARTIAL DENTURES

RPDs have been associated with loss of periodontal attachment and marginal bone loss adjacent to abutments. However, in patients free of periodontal disease when the prosthesis was inserted and where adequate plaque control is maintained, there is little, if any, difference in marginal bone loss between abutments and corresponding uninvolved teeth. Occlusal problems have been documented to occur within 5 years as a result of accelerated vertical residual ridge resorption with distal extension RPDs.
FIXED PARTIAL DENTURES

Teeth that support FPDs do not experience significantly greater rates of marginal bone loss than unin- volved teeth. The mean annual rate of bone loss in either case is close to 0 mm for up to 15 years.63-67 In all reports, authors emphasized that subjects were free of periodontal disease and adequate plaque control was maintained throughout the period of observation.

IMPLANT-SUPPORTED PROSTHESSES

The majority of the bone loss (about 1 to 2 mm) adjacent to endosseous implants supporting complete fixed prostheses occurs during healing and remodeling periods.16,18,20 Minimal, if any, annual bone loss (0 to 0.08 mm) occurs in subsequent years.10,15,20,68 Studies to date are inconclusive with respect to differences between maxillary and mandibular bone loss.16,69

Mean annual bone loss surrounding implants that support overdentures is more or less the same as that found in implant-supported fixed complete prostheses, possibly with more bone loss occurring in the maxilla compared with the mandible.23,70,72 This difference has been attributed to poorer bone quality in the maxilla and increased mucosal irritation surrounding the shorter abutments required for these prostheses.70

The presence of an implant overdenture may affect bone loss at sites remote from the implants. Jacobs et al.73 reported an 11% reduction in bone height distal to implants supporting overdentures compared with a 4% reduction adjacent to implants associated with fixed prostheses after 10 years. This disparity may be due to differences in anterior and posterior support. Anteriorly, the implants take the occlusal load, but posteriorly, it is taken by the residual ridge. Patients with maxillary dentures undergo a 4% vertical bone loss in the anterior or maxilla opposing mandibular implant-supported overdentures or fixed prostheses compared with 13% for those opposing conventional mandibular dentures.74 This finding was attributed to increased instability of the conventional mandibular dentures, which caused unfavorable stress distribution to the opposing arch.

Mean annual bone loss (0.05 to 0.10 mm) for implants supporting FPDs is similar to other implant treatments.75-78 Higher mean annual bone losses (0.10 to 1.01 mm) have been documented adjacent to implant-supported single tooth prostheses in partially edentulous mouths.79-82 Greater bone remodeling may occur adjacent to implants in partially edentulous mouths because these implants are more likely to be surrounded by alveolar rather than basal bone.78

DISCUSSION

The emphasis on tooth replacement has overshadowed the need for preservation of alveolar bone. The best prosthodontic treatment would preserve or even replace missing alveolar bone to provide support for RPDs, esthetically pleasing pontics for FPDs, or to provide stable bone sites for implants.

Resorption of alveolar bone seems inevitable when teeth are lost, yet variability exists between persons, both between and within the jaws, and over time. It would seem that bone that has undergone higher rates of resorption initially will continue to resorb excessive-ly compared with bone that has undergone lower rates of resorption.

Whether wearing a RPD, either supported by mucosa or teeth, is associated with residual ridge resorption has not been clarified. Immediate dentures seem to preserve the buccal plate of bone leave a residual ridge of greater width, yet the edentulous ridge is still subject to vertical bone loss. The composition of the opposing dentition and the presence of parafunc- tional occlusal forces also influences the resorption of the residual alveolar bone. With appropriate plaque control, roots or teeth, supporting RPDs, and over-dentures may act as effective means of preserving adjacent alveolar bone. Unfortunately, distal extension RPDs are still prone to ongoing residual ridge resorp- tion in posterior regions.

The use of endosseous implants to support fixed or removable prostheses has been shown to preserve adja- cent remaining alveolar bone. The reported mean annual bone loss is minimal and similar to healthy natural teeth. However, as with natural teeth, implants are not immune to bone loss, primarily due to excessive occlusal force. Implant-supported overdentures may also preserve adjacent bone, yet bone loss in distal extension areas is similar to that observed with removable prostheses and may result in changes in occlusion and excessive forces being placed on the implants.

CONCLUSIONS

The use of implant-supported fixed prostheses to replace missing teeth in partially or completely edentulous jaws is a highly successful prosthodontic treatment. An often-overlooked benefit of implant-supported fixed prosthetic treatment is the preservation of residual alveolar bone.

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Reprint requests to:
DR. CHRIS C. L. WYATT
DEPARTMENT OF ORAL HEALTH SCIENCES
FACULTY OF DENTISTRY
THE UNIVERSITY OF BRITISH COLUMBIA
2199 WESBROOK MALL
VANCOUVER, BRITISH COLUMBIA
V6T 1Z3
CANADA


0022-3913/98/$5.00 + 0. 10/1/92202