Effect of Prefabricated Bar Design With Implant-Stabilized Prostheses on Ridge Resorption: A Clinical Report

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This investigation was concerned with the resorption of the posterior mandibular residual ridge in patients wearing mandibular overdentures supported by either parallel-sided bars (rigid joint) or oval straight bars (resilient joint) on two activated implants. Rotational tomographs were taken shortly after implant placement and up to 8 years later. Using proportional measurement, the area of residual ridge was measured in bilateral posterior areas. Patients rehabilitated with implant-stabilized mandibular overdentures demonstrated posterior mandibular residual ridge resorption at low rates, which were not significantly influenced by the design of the prefabricated bar. (INT J ORAL MAXILLOFAC IMPLANTS 1998;13:77–81)

Key words: bone resorption, dental implants, mandible, overdentures, residual ridge

The primary reason for restoration of the edentulous mandible with implant-stabilized prostheses is the improved function and comfort associated with minimizing or eliminating movement of the mandibular overdenture. Naturally, for the treatment to be justified, it must be proven successful over an extended period of time. A majority of the clinical research has been associated with establishing the survival of the implant.[1,2] Further, the effects of different prosthesis designs, including comparison of the use of different anchorages,[3] have been widely reported.

Another beneficial result is that providing implant support for the prosthesis will preserve the existing residual bony ridge. Jacobs et al[4] have shown minimal resorption in a group of patients wearing mandibular fixed prostheses supported by four to six implants; this result is predictable because all of the functional load is transmitted to the bone via the implants. For removable implant-stabilized prostheses, the situation is different. Current thinking recommends the use of two implants, with a resilient joint between the prosthesis and its attachments to the implants. A group of patients wearing mandibular overdentures supported by two implants connected by a bar (resilient joint) showed annual posterior jaw bone resorption (excluding a 6-month postextraction remodeling period) two to three times that of conventional complete denture wearers.[4] However, this difference disappeared when comparing groups that had been edentulous for more than 10 years. With overdentures, the transfer of occlusal load to the mandibular bone must be shared by the implants and the posterior residual ridge, with the attachment design influencing the relative load.[5] Where a bar fixed to two implants is used, different shapes may provide different results. Spaced oval or round bars allow both vertical and rotational movements, while parallel-sided bars may transmit more load to the implants and less to the posterior residual ridge.[6,7]

This study investigated the resorption of the posterior mandibular residual ridge in patients wearing mandibular overdentures supported by two Brånemark system implants (Nobel Biocare, Göteborg, Sweden) connected by a bar. The patients were edentulous in both jaws and were treated similarly except that one group was provided with parallel-sided or angular bars (rigid joint), and the other with oval or round straight bars (resilient joint).

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Materials and Methods

Rotational tomographs were taken routinely at intervals during treatment and follow-up, and, in particular, radiographs were taken shortly after implant placement and up to 8 years later. The bilateral posterior areas of the residual ridge were measured (Figs 1a and 1b) using a method of proportional measurement similar to that described by Wilding et al.[8] These posterior areas are bounded by a line joining the gonion to the lower border of the mental foramen and by the crest of the residual ridge. The areas are expressed as a proportion of further areas of bone, which are independent of the crest of the residual ridge; that is, posterior triangles formed on each side by gonion, the lower border of the mental foramen, and a point representing the center of the triangle gonion, mental foramen, and sigmoid notch. By comparing proportions rather than actual measurements, errors related to the distortion and magnification inherent in rotational tomographic radiographs were minimized. The landmarks were traced from the radiographs and then digitized, and the necessary calculations were completed by a dedicated computer program. Means of the posterior area indices for the groups of radiographs were compared using paired *t* tests.

Patient Selection. Twenty patients with suitable radiographs, all of whom experienced continuing functional problems despite the provision of technically satisfactory complete dentures, were drawn from those selected for a previous clinical trial.[2] All of the patients were clinically judged to have little or no residual mandibular alveolar ridge, but an indication of the height of the mandible was obtained by direct measurement on the radiographs in the region of the mental foramen. An attempt was made to discover how long the patient had been edentulous in the mandible.

The trial protocol dictated the placement of four implants in the anterior mandible between the mental foramina; however, for three patients with smaller mandibles only three implants were used. Placement of the implants was influenced principally by the dictates of the surgical technique and the potential denture space. The two distal implants were used to support a prefabricated precision bar, and the mesial implant(s) were held in reserve, unexposed.

Prefabricated precision gold alloy (Dolder) bars of ovoid or parallel-sided shape were soldered to the mesial aspects of gold alloy cylinders secured on the abutments of the distal implants. Either straight ovoid bars with a resilient joint between the denture and the bar or parallel-sided bars and a rigid joint

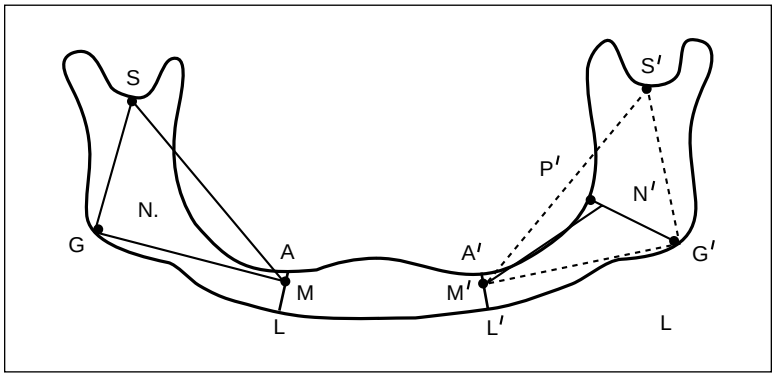

Fig 1a The anatomic landmarks, M, M' (lower border of mental canal), S, S' (sigmoid notch), and G, G' (gonion), were used to construct the triangles M-S-G and M'-S'-G' with centers N and N', respectively. Boundary lines were constructed as follows: M-G and M'-G'; A-L and A'-L' (crest of residual ridge to lower border of mandible perpendicular to M-G and M'-G'); M-N and M'-N'; G-P and G'-P' (G-N and G'-N' extended to the crest of the residual ridge at P and P').

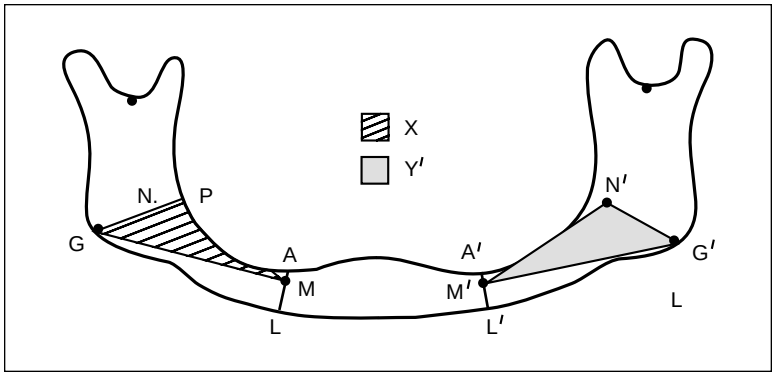

Fig 1b The areas were defined as follows: X and X' by the crest of the residual ridge P-A and P'-A', and the boundary lines A-M and A'-M', M-G and M'-G', and G-P and G'-P', respectively; and Y and Y' by the triangles M-G-N and M'-G'-N', respectively. The posterior area index was calculated from (X/Y + X'/Y')/2.

were used. Retention for the denture was created with a matching sleeve. Straight bars, positioned parallel with the mandibular hinge axis, were preferred in most patients even if the placement appeared to encroach upon the anterior tongue space. However, in some patients it was necessary to use an angular[9] bar to avoid excessive bulk in the denture, and these were considered to have a rigid joint.

Two equal groups of patients, 10 with straight ovoid prefabricated bars with a resilient joint and 10 with straight parallel-sided and/or angular bars with a rigid joint, were investigated. In all patients, the mandibular prosthesis was opposed by a maxillary complete denture.

All of the patients except one were female and the age range was 33 to 72 years. The mean age for the resilient joint group was slightly higher (60 years, range 52 to 72 years) than that of the rigid joint group (52 years, range 33 to 72 years).

Results

There was no significant difference in the initial height of the mandible as measured in the region of the mental foramen between the resilient group (15.6 mm; range 10.5 to 26 mm) and the rigid group (15.4 mm; range 7 to 22.5 mm). Nor was there a significant difference in the average length of time the groups had been edentulous (resilient group = 14.6 years, range = 4 to 32 years; rigid group = 15.2 years, range = 2 to 42 years) (Table 1). The subjects had been wearing their implant-stabilized prostheses for a minimum of 3 years and a maximum of 8 years.

Posterior bone resorption associated with the wearing of the overdenture, expressed as a fraction of the delineated bone surface, was on average +0.057 for the resilient joint group and +0.047 for the rigid joint group. This translates to an annual rate of posterior bone resorption of +0.011 for the resilient joint group and +0.009 for the rigid joint group (Table 2). Application of Student's *t* test failed to show a significant difference between the two groups.

The data were also examined to determine differences in posterior bone resorption associated with the length of time the subject had been edentulous in the mandible. Six subjects had been edentulous for less than 10 years and 14 subjects for more than 10 years. The mean age for those with longer denture experience was 57.9, which, not surprisingly, was greater than for those with shorter denture experience (51.2). Similarly, the mean initial height of the mandible (19.4 mm) was greater for those with shorter experience than for those with longer experience (13.4 mm). Nevertheless, the posterior bone resorption expressed as a fraction of the delineated bone surface was on average +0.069 and +0.044, respectively, for the two groups. This translates to an annual rate of posterior bone resorption of +0.013 and +0.009 (Table 3). Application of Student's *t* test again failed to show a significant difference between the two groups.

Table 1 Subjects' Age, Time Edentulous, and Initial Height of Mandible by Group

	Age		Time edentulous		Initial height (mm)	
Group	Range	Mean	Range	Mean	Range	Mean
Resilient joint	52–72	60	4–32	14.6	10.5–26.0	15.6
Rigid joint	33–72	52	2–42	15.2	7.0–22.5	15.4
Edentulous ≤ 10 years	33–66	51.2	2–7	4.3	13.0–26.0	19.4
Edentulous > 10 years	43–72	57.9	10–42	19.4	7.0–20.5	13.4
All subjects	33–72	55.9	2–42	14.9	7.0–26.0	15.5

Table 2 Posterior Mandibular Bone Resorption According to Bar Design*

Group	Mean resorption	SD	Range
Resilient joint	0.057	0.081	–0.015–0.260
Rigid joint	0.047	0.065	–0.050–0.155
	Annual rate		
Resilient joint	0.011	0.015	–0.005–0.048
Rigid joint	0.009	0.011	–0.009–0.029

*Resorption expressed as a fraction of the delineated bone surface.

Table 3 Posterior Mandibular Bone Resorption According to Time Edentulous*

Group	Mean resorption	SD	Range
Edentulous ≤ 10 years	0.069	0.116	–0.050–0.26
Edentulous > 10 years	0.044	0.047	–0.035–0.13
	Annual rate		
Edentulous ≤ 10 years	0.013	0.021	–0.009–0.048
Edentulous > 10 years	0.009	0.0109	–0.006–0.029

*Resorption expressed as a fraction of the delineated bone surface.

Discussion

Mandibular residual ridge resorption following loss of teeth and placement of complete dentures is a well-established phenomenon,[10] which has been correlated with length of denture experience.[11] However, most studies have avoided the difficulties of investigating posterior ridge resorption, concentrating instead on anterior segment measurements from cephalometric radiographs. Methods for measuring posterior ridge resorption from cephalometric radiographs[12,13] have been suggested, but such radiographs are not now used in routine clinical practice. Consequently, Wilding et al[8] proposed the use of panoramic radiographs to measure residual bone areas and demonstrated an interobservation error for the area index of 4.9%. Jacobs et al[4] subsequently confirmed an interexaminer variability of 4% and suggested a threshold for the area index of 0.04 for detecting bone resorption. The mean difference between the two sets of radiographs in all groups was always higher than this threshold in our study, although individual pairs of radiographs sometimes failed to show such a difference. For three patients, a negative difference—that is, an increase in area index equivalent to bone formation—was shown. However, with one exception, this was less than the threshold established for determining actual change, and no conclusion can be drawn from this small group.

Direct comparison of the results from this study can only be made with that of Jacobs et al,[4] who used a similar method to study three groups of patients wearing different types of prostheses. One group was wearing mandibular overdentures stabilized by an oval Dolder bar on two implants, which is directly comparable to this study. The other groups were wearing fixed mandibular prostheses and complete dentures, respectively. They also presented their results according to the time lapse for the edentulous state, so that, in this respect, similar groups can be compared. Since, in our study, no significant differences were shown for the two groups with different bar designs, all subjects were used when the annual rate of posterior bone loss was calculated to be 0.013 for the less than 10 years group, and 0.009 for the greater than 10 years group. These results compare with 0.12 and 0.11 in the study by Jacobs et al, an annual rate of bone loss almost 10 times that found in the present study.

The different outcomes of the two studies may be attributable to specific variations between the groups of subjects, although factors relating to the method of prosthetic treatment and design of the overdentures cannot be excluded. In the study by Jacobs et al, 14% of the patients had either some natural teeth or a fixed implant-stabilized prosthesis in the arch opposing the overdenture. An increased rate of resorption was recorded for this group. Another factor may be the status of the mandibular bone at the start of the study, since Jacobs et al reported moderate bone quality and moderate alveolar bone resorption as usually being present, whereas in our group all subjects had little or no residual mandibular ridge. Although there are no data available correlating denture-bearing area with bone resorption,[14] it is generally accepted that the rate of bone resorption reduces with time after extraction.[10,14] Patients in the current study had been edentulous for longer (mean 14.9 years; range 2 to 42 years) than those reported by Jacobs et al (mean 10 years; range 0.5 to 36 years). Other influences may include differences in the extension of the denture base and other aspects of prosthetic design and treatment, but such details were not reported.

Other groups studied by Jacobs et al showed average annual rates of posterior residual ridge resorption after the first postextraction period of remodeling of 0.04 for the fixed prostheses group and 0.10 for the complete denture group. They suggested that the resilient connection between overdenture and bar allowed free rotation during posterior loading, thereby contributing to increased resorption of the posterior ridge. This finding was not confirmed in the present study, even for the resilient joint group.

However, the resilient joint group did show a higher rate of resorption than the rigid joint group, although the difference was not significant. This lack of significance may be explained by the generally low rate of resorption and the small numbers investigated. Further, the assumption that different designs of bar used leads to noticeable differences in the rigidity of the connection may be incorrect and requires further investigation.

One of the advantages claimed for overdentures stabilized by retained roots is the protection of the supporting tissues provided by proprioceptive feedback. Such feedback is not physiologically present for implant-stabilized overdentures. It would be interesting, however, to use this method to investigate posterior mandibular residual ridge resorption for both root-stabilized overdentures and various designs of distal extension–based removable partial prostheses.

Conclusion

Patients with severe mandibular resorption rehabilitated with implant-stabilized mandibular overdentures demonstrated low rates of posterior mandibular residual ridge resorption, which were not significantly influenced by design of the prefabricated bar.

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