The Prevention of Periodontal Bone Loss at the Osteotomy Site After Anterior Segmental and Dento-Osseous Osteotomy

The prevention of periodontal bone loss at the osteotomy site following anterior segmental and dent-osseous osteotomy

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Abstract

Purpose: Degeneration of the gingival margin and periodontal bone loss between segments can occur in various segmental osteotomies. However, treatment and management of these problems have not yet been resolved; improvement of the conventional method is necessary. The purpose of this retrospective study is to evaluate the usefulness and advantage of orthodontic devices in osteotomies.

Patients and Methods: Forty Japanese adults presented, jaw deformities diagnosed as mandibular prognathism with maxillary protrusion, bimaxillary protrusion, and anterior crowding. Of these 40 patients, 20 (Group 1) underwent anterior segmental osteotomy or dento-osseous osteotomy along with our original orthodontic periodontal management. The remaining 20 (Group 2) patients underwent conventional procedures. After surgery, pocket depth and periodontal bone loss at the osteotomy site was evaluated.

Results: In all cases of patients who underwent our original technique, degeneration of the gingival marginal and periodontal defects at the osteotomy site were not found. The rate of alveolar bone height in Group 1 significantly increased and that in Group 2 significantly decreased after maxillary osteotomy ($P<0.05$).

Conclusion: This technique may prevent periodontal defects from occurring at the interdental osteotomy site.

Introduction

The correction of dentofacial deformities by surgical-orthodontic approaches has become common. Regarding segmental and dento-osseous osteotomies, many articles have described various surgical techniques, case reports, and animal studies confirming the vitality and uneventful healing of the involved segments, as well as the predictable function and esthetic results of surgery[1-8].

Maxillary and mandibular anterior segmental osteotomies are effective, selective, relatively safe and simple methods for correcting lower facial profile disharmony to attain a satisfactory aesthetic facial contour. However, esthetic aspects of periodontal tissue should be also considered. Merrill and Pederson reported on 4 of 65 patients who developed periodontal defects following interdental osteotomies with close root approximation[7]. Dorfman and Turvey reported on 2 of 22 patients who showed periodontal bone loss at the interdental osteotomy sites[9]. Schultes et al. reported that 51 pathologic periodontal lesions were found in 74 segmental osteotomy sites, 35 segmental areas with osseous periodontal defects, and 16 segmental areas with missing teeth[10].

We have also experienced some cases in which bone loss occurred following conventional segmental osteotomies. Therefore, establishing a reliable technique for preventing these periodontal problems is necessary.

The purpose of this study was to retrospectively evaluate our attempts to prevent gingival bone loss at the osteotomy site by using orthodontic devices during surgery.

Patients and Methods

Patients

Forty Japanese adults (ranging in age from 15 to 55 years, with a mean age of 25.9 years, standard deviation 8.8 years) presented with jaw deformities diagnosed as mandibular prognathism, maxillary protrusion, bimaxillary protrusion, anterior crowding, and anterior openbite, and their cases were evaluated retrospectively. They rejected orthodontic treatment for long period and hoped shorter treatment period, so that anterior segmental osteotomy was selected. Our original method has been used for Group 1 since 2000, and conventional method had been used for Group 2 until 1999.

The experimental group (Group 1) was composed of 20 of the above 40 patients (ranging in age from 18 to 55 years, with a mean age of 28.8 years, standard deviation 7.8 years). These patients underwent maxillary and/or mandibular segmental osteotomy and/or dento-osseous osteotmy under general anesthesia. In this study, we defined segmental osteotomy as involving more than two teeth and dento-osseous osteotomy as involving just a single tooth. Two cases were performed in combination with mandibular ramus osteotomy (intra-oral vertical ramus osteotomy and sagittal split ramus osteotomy).

Rigid fixation was obtained with absorbable mini-plates and monocortical screws (Fixorb®-MX, Takiron Co., Osaka, Japan) as necessary. For maxillo-mandibular fixation, elastic bands were placed to maintain ideal occlusion in the two patients who underwent mandibular ramus osteotomy.

Orthodontic multi-brackets (0.020-inch slots) were attached to the buccal or labial tooth surfaces immediately before surgery. All patients in group1 received orthodontic treatment before and after surgery.

Maxillary surgical procedure

All patients in Group 1 underwent segmental or dento-osseous osteotomy following a gingival margin (full-thickness intrasulcular) incision along the anterior teeth, involving one tooth posterior to the osteotomy line from the buccal or labial side, positioned to hide the subsequent scars. No palatal incision was made to preserve the palatal blood supply.

The vertical osteotomy and horizontal osteotomy were carried out buccally and labially with a sagittal saw. The horizontal osteotomy line was determined above the anterior nasal spine, like the anterior part of a Le Fort I osteotomy. After nasal mucosa was detached from the nasal floor, the anterior nasal septum was cut with an osteotome. The hard palatal region of the maxillary anterior segment was fractured with a curved osteotome from the anterior site through the nasal floor. If tooth extraction was needed, it was done before the proposed osteotomy was completed. The required amount of bone was resected from the alveolar bone and the hard palate. Following complete and adequate mobilization of the maxillary anterior segment, further interdental osteotomy was performed to make dento-osseous fragments if necessary. Then they were aligned and held in the desired position with pre-formed squared arch wire (SENTALLOY® ARCH WIRES 0.020×0.020 or 0.018×0.018 inches, TOMY INTERNATIONAL, Tokyo, Japan) tied to multi-brackets with ligature wires and an elastic power-chain

(F.M. RINGLET® closed type, rocky mountain corporation, Tokyo, Japan). If necessary, a rigid bone segment was fixed with an absorbable mini-plate and screw. If a bone graft was necessary, resected bone was used. Intermaxillary fixation was not necessary in all cases. After the flap was repositioned, suturing was carried out securely at every inter-dental region so as not to lose periodontal attachment.

Mandibular surgical procedure

A gingival marginal (full-thickness intrasulcular) incision was performed in all patients in the same manner as in maxillary osteotomy (Fig. 1). With care not to disturb the inferior alveolar nerves, the mucoperiosteum of the anterior portion of the mandible was reflected to expose the proposed osteotomy site. The operation that followed was performed in a manner similar to a maxillary osteotomy.

Postoperative treatment

After 1-2 weeks, when complete mucogingival healing had been achieved, the elastic power-chain was removed. However, in cases in which the interdental space at the osteotomy site was still large and periodontal tissue healing was unfavorable at this time, the power-chain was used continuously. Furthermore, when the formation of interdental papillae was necessary, the contact square between adjoining tooth crowns was enlarged vertically and the interdental space was closed with an elastic power-chain (Fig. 1). When the patient desired further orthodontic treatment, it was continued. When the patient was satisfied with the occlusion immediately after surgery and we judged that this occlusion could be maintained for a long time, the multi-brackets were removed. Then, a lingual retainer was fixed to the anterior teeth and a removable occlusal splint was provided or prosthetic treatment was prepared. At regular follow-up visits, consistent periodontal treatment was carried out.

The other group (Group 2) was composed of the remaining 20 Japanese adults (ranging in age from 15 to 45 years, with a mean age of 23.1 years, standard deviation 9.0 years) with jaw deformities. These patients underwent conventional Köle treatment for mandibular deformities and Wassumund and Wanderer methods for maxillary deformities under general anesthesia; if necessary, an additional vertical osteotomy was performed. These methods had been used previously in our hospital and the age distribution of this group was similar to that of Group 1, so these patients could be used as a comparative group. Four patients underwent osteotomy in combination with sagittal split ramus osteotomy. Seven of the 20 patients received orthodontic treatment with the multi-bracket system. However, the remaining 13 patients received arch bars or similar types of devices to stabilize the segments, and circumdental wires were used at the cervical margins. Titanium mini-plates and screws (2 × 7 mm) (Würzburg titanium miniplate system, Leibinger Co., Freiburg, Germany) were used for segmental fixation in all patients. Intermaxillary fixation was not used in all patients.

All patients were followed up at preoperative and postoperative 1 month, 3 months, 6 months and 12 months. Orthopantomographs were taken for every patient in each period. The periodontal status was assessed at the distal aspect of canine in osteotomy sites using 3- 12 months orthopantomographs, after judged that periodontal status was stable. The clinical examination consisted of evaluation for the pocket depth and alveolar bone height (the total length from the root apex to the alveolar crestal height) at preoperatively and postoperatively. Pocket depth was measured with pocket probe by one of the oral surgeons who cooperated in the operation. Alveolar bone height and tooth length were measured at distal aspect of canine near the osteotomy line using the orthopantomographs, because the osteotomy line at the canine region was performed in all cases and bone change was clearer than other regions (Fig. 2). The measurement of alveolar bone using orthopantomographs was performed by an oral surgeon who performed the operation. The images of orthopantomographs were enlarged and inconsistent, so that it was necessary to standardize the value of measurements. Therefore, the ratio of alveolar bone height to tooth length (alveolar bone height)/(tooth length) was calculated.

Mann Whitney's U test and Wilcoxon signed-ranks test using Stat View 4.5 (Abacus Concepts, Inc., Berkeley, CA, USA) were applied for the comparison of groups. The χ^2 test was used for comparing the frequencies of group levels with Stat View 4.5. The differences were considered significant at $p<0.05$.

Results

In Group 1, 23 teeth (most first pre-molars) were extracted for osteotomy. The number of segments was 64. There were no pathologic periodontal findings in the 86 osteotomy sites. Lateral root resorption in the region of the osteotomy site was not found. There was no sudden tooth loss at the osteotomy site. No tooth needed endodontic treatment due to a root apical lesion, although it was unclear whether pulp nerve was vital or not.

On the other hand, in Group 2, 31 teeth (most first pre-molars) were extracted for osteotomy. The number of segments was 25. However, there was periodontal bone loss in 9 of the 49 osteotomy sites (18.4%). One of the 9 teeth was lost unexpectedly because most of the root was exposed and the site showed fatal bone loss. Endodontic treatment was needed for three teeth. The incidence rate of periodontal bone loss in Group 1 was significantly lower than that in Group 2 (P<0.05).

In pocket depth and the rate of alveolar bone height, 28 sites in maxilla and 20 sites in mandible for Group 1 and 10 sites in maxilla and 34 sites in mandible for Group 2 could be measured and evaluated. Regarding pocket depth, there was no significant difference between Group1 and Group2, except for preoperative value in maxilla (P<0.05). Postoperative pocket depth was significantly smaller than preoperative one in maxillary and manbibular osteotomies (P<0.05). On the other hand, regarding the rate of alveolar bone height, there were no significant differences between Group1 and Group2, except for postoperative value in mandible (P<0.05). The rate of alveolar bone height in Group 1 significantly increased and that in Group 2 significantly decreased after maxillary osteotomy (P<0.05) (Table 1.).

Discussion

Following orthognathic surgery, the periodontal marginal loss of the teeth bordering the osteotomy site is one of the most important problems.

Kent and Hinds suggested that flap design and approximation of segments were the most important factors affecting postoperative periodontal pocket formation and subsequently the development of periodontal disease[6]. Burke et al. reported the occurrence of interdental papilla destruction and periodontal pocket formation when labial stripping was followed by cortical osteotomies extending through the crestal ridge[3].

Generally, there are four accepted approaches for the maxilla: the Wassmund, the Wunderer, the Epker, and the Bell[1,11-13]. In these procedures, periodontal marginal incision was not performed, but a very complicated approach to the bone was carried out in order to not impede the blood supply to the anterior bone. Our flap design clarifies the operation field so that an osteotomy can be performed in cases of slight anterior crowding. The most important pedicle supply is that derived from the palate, but even this is not dependent upon the preservation of the greater palatine arteries. In the mandible, the osteotomy segment derives its blood supply from the soft tissues attached to the lingual aspect and it is of paramount importance that this attachment is maintained during the surgical procedure. Our flap designed for the mandible could also be easier to use than that in the Köle method[14].

In fact, a periodontal marginal (full-thickness intrasulcular) incision was also used in many periodontal surgeries such as the open-flap operation[15]. This incision method itself is not considered to cause loss of periodontal tissue because preoperative periodontal disease was cured.

However, when the gingival margin is considered in segmental and dento-osseous osteotomy, the preservation of periodontal ligament is crucial. The flap we designed has sufficient mobility and stretch to cover all areas of exposed bone and periodontal membrane without tension. Isaka et al. concluded that periodontal ligament cells acted on the regeneration of the periodontal ligament with new cementum formation, and might have a limited influence on alveolar bone formation during the course of periodontal regeneration in the experimental study[16].

Furthermore, optimal compression induces better osteosynthesis in fracture healing[17-19]. In our original methods, pre-formed squared wire was used for fixation so that continuous torque force could bring the segments closer near the roots. The elastic power-chain could give every osteotomy site between the segments optimal compression force to improve bone healing at the osteotomy sites. For immediate orthodontic force, rigid fixation with a titanium plate was not necessary. Several dentists have reported orthodontically moving teeth into infrabony defects, showing the possibility for modifying the defects' morphology and thus obtaining probing depth reduction and radiological bone defect resolution[20-23]. The concept of these studies can be applied to teeth at osteotomy sites immediately after segmental and dento-osseous osteotomy. When the distance between segments was large, the distance between the neighboring teeth at the osteotomy line was closed until the gingival mucosa healed completely. A bone graft was not needed in this method. If the space between the neighboring teeth at the osteotomy site was needed to establish the ideal occlusion, the space at the site should be opened to the desired distance after the mucous tissue healed completely. The most important thing was to bring the segments into contact immediately after surgery. If space was open between the repositioned segments, stress on the soft tissues or tearing could cause periodontal conditions. Bone gaps created between the alveolar segments could also lead to periodontal problems.

In this study, although bone loss occurred postoperatively, periodontal pocket depth seemed to be kept in Group 2. This suggested that gingival tissue degenerated in accordance with bone loss. Even if pocket depth was kept, gingival shape was not good esthetically in some cases in Group 2. In contrast, the result proved that gingival tissue was not damaged after surgery in Group 1.

Poor oral hygiene, postoperative traumatic occlusion, or inappropriate orthodontic mechanics can exacerbate a periodontal condition. Use of circumdental wires at the cervical margins might induce periodontal bone loss in Group 2. Conversely, appropriate biomechanical force, such as occlusal force, and orthodontic treatment can improve the periodontal condition and induce bone regeneration even after segmental osteotomy, as shown in Group 1.

In conclusion, surgeons must consider periodontal tissues in oral surgery. Our technique of using an elastic power-chain and pre-formed wire during an oral operation can easily prevent the occurrence of periodontal defects at the interdental osteotomy site and ensure the esthetic gingival margin, without the necessity of a bone graft.

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Legends

Figure 1. Orthodontic forces immediately after surgery. A: Pre-formed wire with squared sections was used for fixation so that continuous torque force could bring the segments closer near the roots. The elastic power-chain could give every osteotomy site between the segments optimal compression force so that bone healing at the osteotomy sites would improve. B: The formation of interdental papilla was induced by closure of the interdental space with an elastic power-chain.

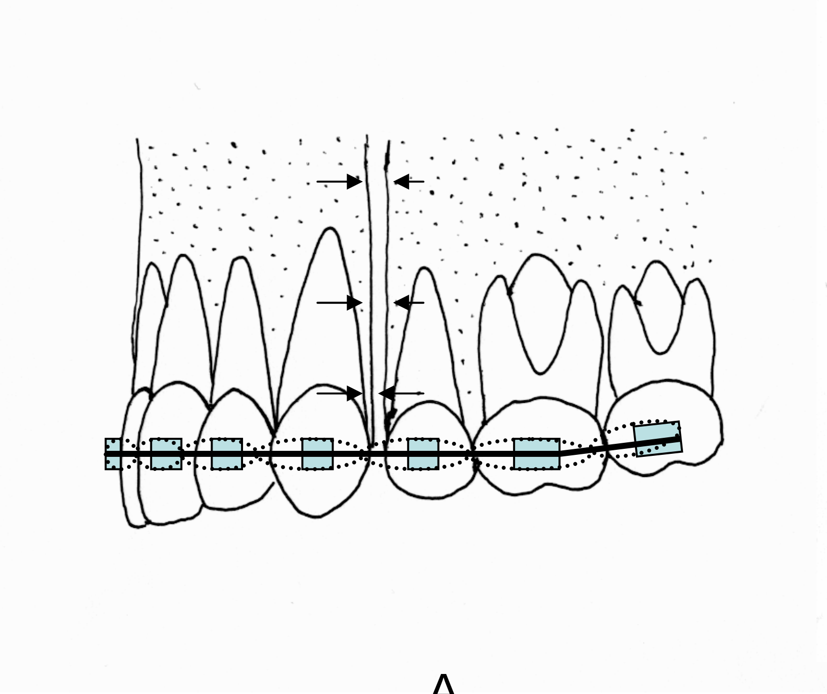
Figure 2. Measurment of alveolar bone height. a) preoperative alveolar bone height, b) preoperative tooth length, a') alveolar bone height after 1 year, b') tooth length after 1 year.

Alveolar bone height and tooth length were measured at distal aspect of canine near the osteotomy line on the orthopantomographs, because the osteotomy line at the canine region was performed in all cases and bone change was clearer than other regions. The images of orthopantomographs were enlarged and inconsistent, so that it was necessary to standardize the value of measurements. Therefore, the ratio of alveolar bone height to tooth length (a/b and a'/b') was calculated. In this case, lower premolars were extracted in mandibular ostetomy.

Table 1. The results of pocket depth and rate of alveolar bone height .

**, statistically significant differences: P<0.05 (Mann Whitney's U test).

*, statistically significant differences: P<0.05 (Wilcoxon signed-ranks test).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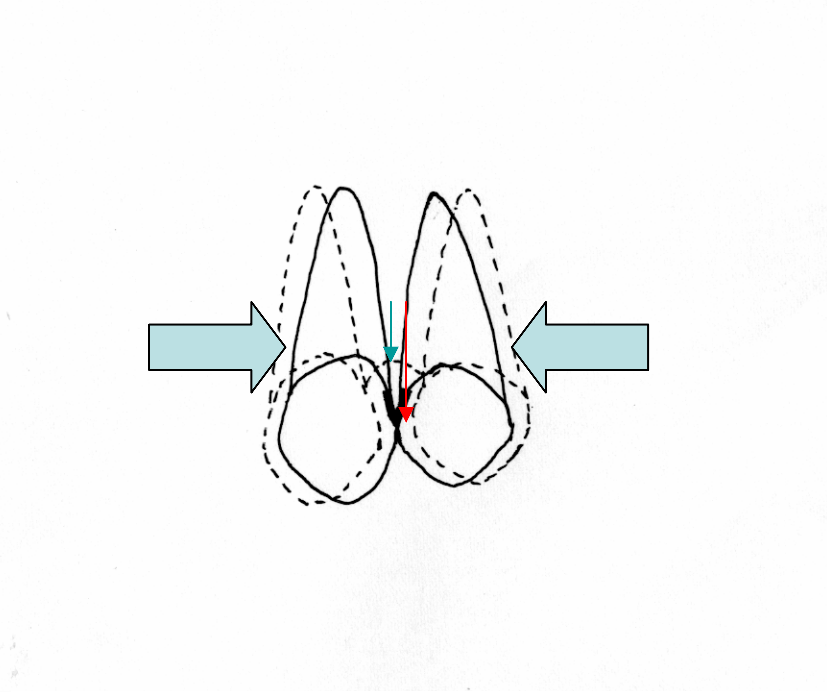
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Fig. 1

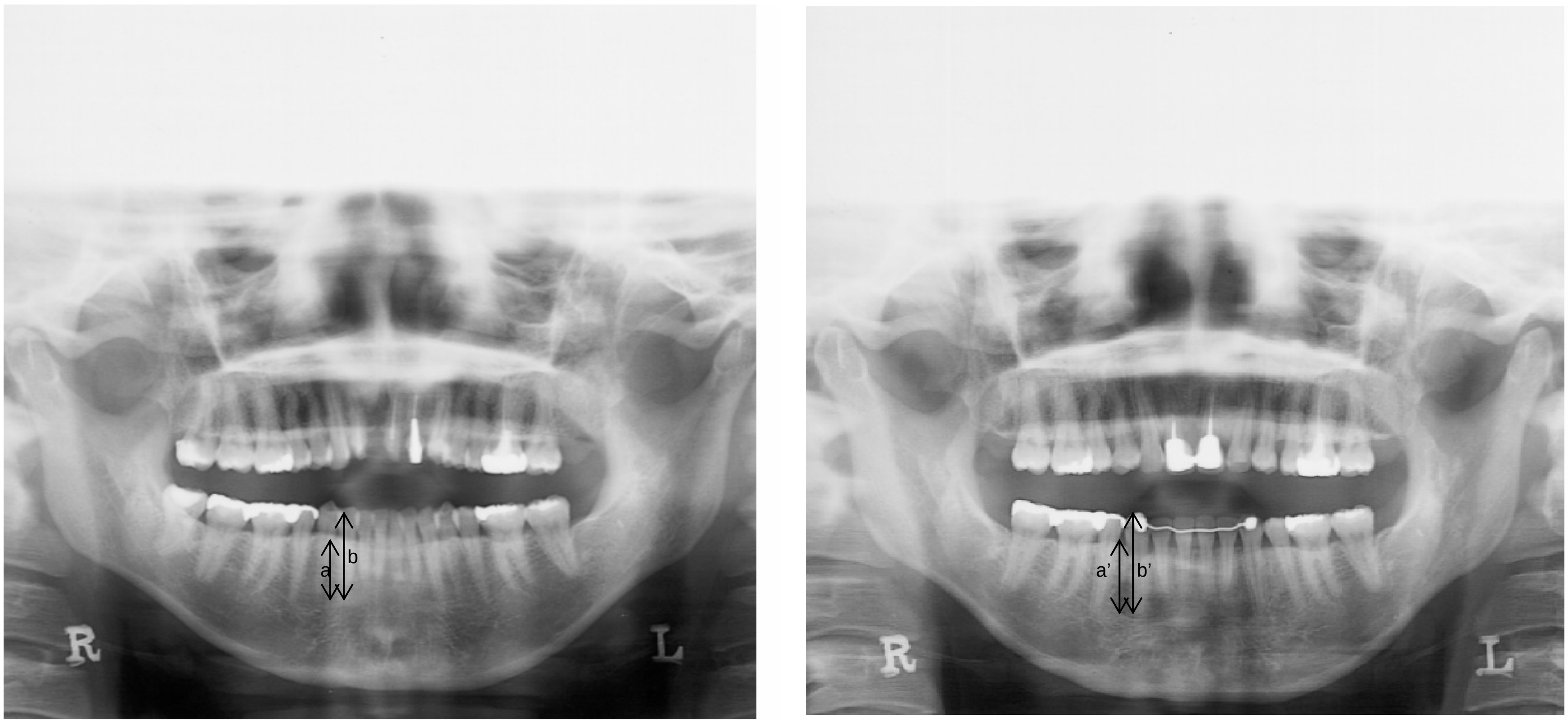

Fig. 2

			Pocket depth (mm)					Rate of bone height				
			Mean	Standard deviation	Median	Interquartile range		Mean	Standard deviation	Median	Interquartile range	
Group 1	Maxilla	Pre	2.8	0.8	3.0	1.0	*	0.61	0.07	0.62	0.10	*
		Post	2.4	0.5	2.0	1.0		0.63	0.07	0.65	0.09	
	Mandible	Pre	2.8	0.7	3.0	1.0	* **	0.62	0.12	0.62	0.08	
		Post	2.3	0.4	2.0	0.5		0.65	0.13	0.67	0.07	
Group 2	Maxilla	Pre	2.5	0.5	2.5	1.0		0.63	0.08	0.66	0.08	* **
		Post	2.8	0.8	3.0	1.0		0.60	0.10	0.62	0.11	
	Mandible	Pre	2.3	0.5	2.0	1.0		0.63	0.40	0.62	0.09	
		Post	2.4	0.7	2.0	1.0		0.61	0.05	0.61	0.05	

Table 1.