Gingival Recession Around Implants: A 1-Year Longitudinal Prospective Study

Paula N. Small, DDS, MPH[1]/Dennis P. Tarnow, DDS[2]

A longitudinal study was performed, which measured the soft tissue around implants following surgery, to determine if a predictable pattern of soft tissue changes could be identified. This study evaluated 63 implants in 11 patients. Baseline measurements were recorded at stage 2 surgery in 2-stage implant systems, and at stage 1 surgery in the 1-stage system. Subsequent measurements were recorded at 1 week, 1 month, 3 months, 6 months, 9 months, and 1 year after baseline measurements. The majority of the recession occurred within the first 3 months, and 80% of all sites exhibited recession on the buccal. It is therefore recommended that one wait 3 months for the tissue to stabilize before either selecting a final abutment or making a final impression. As a general rule, one can anticipate approximately 1 mm of recession from the time of abutment connection surgery. A comparison of this study's results with data recorded in previously reported studies reveals clinically significant trends in the nature of soft tissue healing. (Int J Oral Maxillofac Implants 2000;15:527–532)

Key words: *dental abutment, dental implantation, endosseous dental implants, gingival recession, mouth mucosa*

The majority of the early research concerning soft tissue surrounding implants focused on the histologic nature of the epithelial and connective tissue attachment to the implant. This information is fundamental to understanding the biologic response to implants. More recently, researchers have studied the clinical response of the tissues surrounding implants to determine whether tissues respond in any regular pattern.[1–5]

Brånemark et al[6] reported extensively on tissues associated with osseointegrated implants. His work examined plaque and gingival indices, amount of attached gingiva, presence of calculus, and probing depth. Adell et al recorded the marginal tissue response in a 3-year longitudinal study,[7] and Lekholm et al did the same in a cross-sectional study.[8] The factors they evaluated included the presence of plaque, gingivitis, probing depth, attached gingiva, prosthesis-gingiva distance (from the top of the abutment to the height of the mid-buccal free gingival margin), microbiota, and the histologic condition of the soft tissue. Baseline measurements in the longitudinal study were obtained at the time of prosthesis placement, which was usually 1 month after abutment connection, but due to the nature of Lekholm et al's cross-sectional study,[8] baseline measurements were not taken. Average probing depth was 2.9 mm at 7.6 years in the cross-sectional study[8] and 3.8 mm at 3 years in the longitudinal study.[7] In the longitudinal study, the prosthesis-gingiva distance increased 1.7 mm, from 1.5 mm at 1 month, to 3.2 mm at 3 years.[7] In the cross-sectional study the prosthesis-gingiva distance measured 3.2 mm.[8] There was no mention of the apparent coincidence that in both the longitudinal and cross-sectional studies the prosthesis-gingiva distance was 3.2 mm.

Apse et al[9] looked at peri-implant tissues over a 4- to 9-year period. The study examined plaque, keratinized mucosa, gingival indices, probing depth, and the height of the abutment above the peri-implant mucosa. The authors reported a decrease in probing depth, from 4.27 mm in the first year to 2.51 mm in the ninth year. Abutment height above the peri-implant mucosa increased over the 9-year period, indicating approximately 1.75 mm of tissue shrinkage over 9 years. These results are similar to those reported previously by Adell et al (1.7 mm).[7]

[1]Associate Clinical Professor, Department of Implant Dentistry, New York University College of Dentistry, New York, New York.
[2]Professor and Chairman, Department of Implant Dentistry, New York University College of Dentistry, New York, New York.

Reprint requests: Dr Paula N. Small, Department of Implant Dentistry, New York University College of Dentistry, 250 East 63rd Street, Apt. 19C, New York, NY 10021. Fax: 212-754-6753.

Bengazi et al[10] evaluated peri-implant tissues longitudinally for a 2-year period following prosthesis placement. They measured plaque, mucositis, probing depth, bleeding upon probing, marginal soft tissue level, width of masticatory mucosa, and marginal soft tissue mobility. Though they did not publish an overall mean value for the recession, it appeared to be approximately 0.5 mm. All of the recession occurred within the first 6 months after prosthesis placement, and mandibular lingual sites showed the greatest tendency toward recession.

All of these studies involved the measurement of soft tissue levels at the time of prosthesis placement. To date, no data exist as to the amount of soft tissue recession that occurs from the time of abutment connection surgery. The purpose of this longitudinal study was to measure the soft tissue around implants immediately following placement (in a 1-stage system) or immediately following abutment connection surgery (in a 2-stage system), and at subsequent intervals.

MATERIALS AND METHODS

The patients involved in this investigation were all treated at New York University College of Dentistry, Ashman Department of Implant Dentistry. Selection of the patients was based on a consecutive assignment to 1 resident, and all implants were placed by that resident. Patients were excluded if they were heavy smokers (> 10 cigarettes/day) or if they required a graft (soft or hard tissue) prior to or in conjunction with implant surgery. Patients were not required to complete an informed consent for the study since their treatment course was not altered by the study. The patients required full-arch, partial-arch, and single-tooth replacement. There was a total of 65 implants, in 11 patients and 14 arches (8 maxilla, 6 mandible). The mean age of the patients at baseline was 56 (range 49 to 81). Implants from 4 manufacturers were used: Nobel Biocare AB (Göteborg, Sweden, n = 45 implants; Interpore International (Irvine, CA, n = 7); Stryker (Kalamazoo, Michigan, n = 1); and ITI-Straumann (Waldenburg, Switzerland, n = 12). All surgeries were performed using a midcrestal incision, dividing the keratinized tissue so as to ensure attached gingiva on the buccal and lingual of the implant or abutment. Seven arches were treated with provisional removable prostheses, and 7 were treated with fixed prostheses. Removable provisionals were used to restore totally edentulous arches and in partially edentulous arches with insufficient dentition to support a fixed provisional.

Baseline measurements were obtained for 2-stage systems at the conclusion of abutment connection surgery. Baseline measurements for the 1-stage system were obtained at the conclusion of implant placement. Follow-up examinations were performed 1 week, 1 month, 3 months, 6 months, 9 months, and 1 year after baseline measurements. The measurements were obtained by 1 examiner using predetermined fixed reference points. All impressions were taken at the implant level with pickup type impression copings. Prostheses were placed 1 to 4 months after stage 2 surgery. One-stage implants were restored 7 months after placement in the maxilla and 5 months after placement in the mandible. The type of final abutment and restoration varied among patients. Each time a new component was placed intraorally, appropriate oral hygiene instructions were given to the patients. Each patient received oral prophylaxis at 6-month intervals.

At the initial exam and at the 1-week evaluation visit, a single measurement was obtained: the distance between a fixed reference point on the implant (FRP), ie, the top of the implant shoulder, the gingival margin (GM). This measurement was obtained by measuring the portion of the abutment that remained above the tissue and subtracting this figure from the known total height of the abutment. The resultant figure is the height of the tissue above the implant (Figs 1a and 1b). Four measurements were recorded (mesial, distal, buccal, and lingual) to the nearest 0.1 mm using silver points, a locking pliers, and an electronic caliper. These figures were then rounded off to the nearest 0.5 mm. When the final abutment or prosthesis was placed, its total height above the top of the implant was recorded. Then the height above the gingival margin was recorded and subtracted from the known height of the prosthesis. This was done so that measurements could be obtained without necessitating removal of the prosthesis.

At the 1-month and all subsequent evaluations, 2 measurements were obtained: gingival margin (GM) (as above), and the presence or absence (+ or –) of keratinized gingiva (KG).

The data were analyzed with SAS software (SAS, Cary, NC) employing univariate and multivariate procedures. General analysis of variance techniques for single and multifactor considerations were applied for data that could be treated parametrically, and Kruskal-Wallis non-parametric tests were applied for data that were more appropriately treated non-parametrically. The probabily for Type I error was taken with alpha = .05 as the threshold to determine whether a result was significant. The results were examined for validity by reflecting

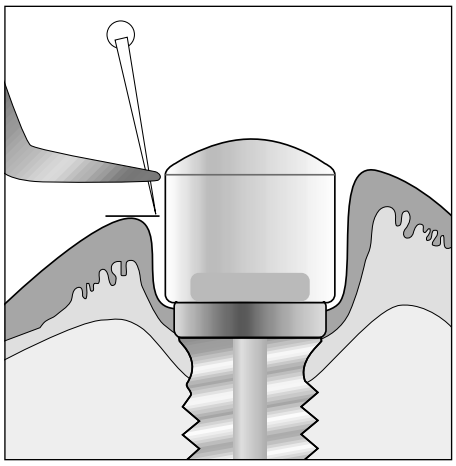

Fig 1a Measurements were taken by placing a silver point at the crest of the gingival margin and securing it with locking pliers against the top of the abutment.

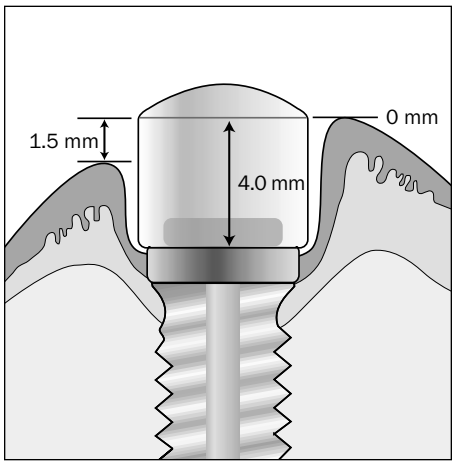

Fig 1b Examples of measurement. (*Left side*) Buccal measurement: 4-mm temporary healing abutment, minus 1.5 mm abutment height above the gingival margin, equals 2.5 mm gingiva above the fixed reference point (top of implant). (*Right side*) Lingual measurement: 4-mm temporary healing abutment, minus 0 mm abutment height above the gingival margin, equals 4 mm gingiva above the fixed reference point (top of implant).

whether the power approached 80% or not for the number of observations made and their variance. The breakdown of variables is a natural outcome of the SAS univariant analysis.

RESULTS

Figure 2 shows longitudinal measurements taken at the 6 different time periods. The mean values of all 4 sites around the implant or abutment showed coronal growth at 1 week after surgery. At 1 month, the mean values indicated recession at all 4 sites around the implant or abutment. Most of the recession occurred during the first 3 months and stabilized by 6 months.

As indicated by the standard deviations (Table 1), great variability was observed. Eighty-two percent of the buccal tissue sites showed recession, 6% showed coronal growth, and 12% exhibited no change (Table 2). Sixty percent of the lingual and mesial tissue sites showed recession, 12% showed coronal growth, and 28% showed no change. Seventy-five percent of the distal tissue sites showed recession, 14% showed coronal growth, and 11% exhibited no change. Of the 8 mesial sites that displayed coronal growth, 3 sites migrated coronally beginning at 1 week, 2 sites migrated beginning at 3 months, and 3 sites began migration at 6 months. Of the 9 distal sites that displayed coronal movement, 2 sites migrated coronally beginning at 1 week, 2 sites at 1 month, 4 sites at 3 months, and 1 site at 6 months.

Maxillary and mandibular data were compared and demonstrated similar means for all 4 sites around the 1-stage implants or abutment at all 6 time periods (Fig 3). The type of provisional restoration employed influenced soft tissue changes in the early time periods (Fig 4). At the 1-week interval, more inflammation was seen beneath removable provisional prostheses than beneath fixed provisional prostheses. At the subsequent 5 intervals, recession occurred beneath both removable and fixed prostheses, but to a greater degree under the fixed prostheses. However, these differences were not statistically significant. The results were also analyzed relative to the type of abutment placed, ie, temporary healing abutment versus final abutment. Lingual tissues showed greater recession around final abutments, while buccal, mesial, and distal tissues exhibited equal recession around both types of abutments.

A total of 98.6% of the implants continued to be surrounded by keratinized gingiva throughout the study. This high percentage was attributed to the midcrestal incision design.

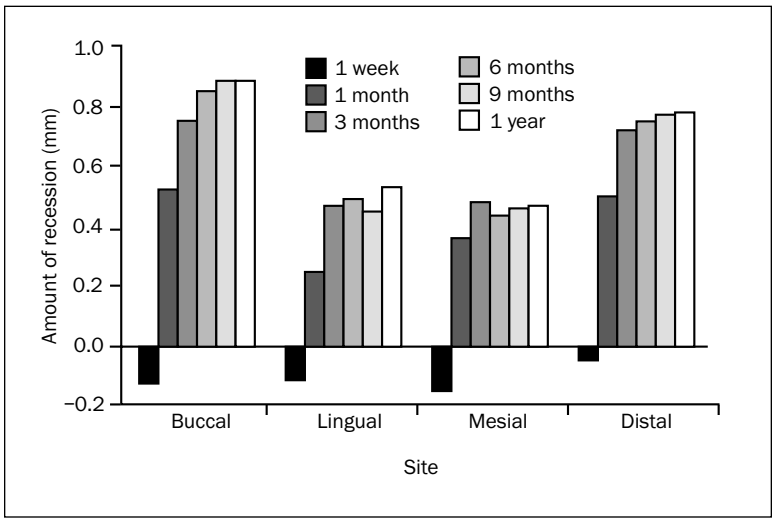

Fig 2 Mean site-specific recession measurements at each interval.

Table 1 Means and Standard Deviations (in mm) of Measurements

Time	Buccal changes	Lingual changes	Mesial changes	Distal changes
1 week	–0.13 ± 0.49	–0.12 ± 0.47	–0.15 ± 0.46	–0.05 ± 0.57
1 month	0.52 ± 0.75	0.25 ± 0.86	0.36 ± 0.70	0.50 ± 0.80
3 months	0.75 ± 0.76	0.47 ± 0.90	0.48 ± 0.80	0.72 ± 0.90
6 months	0.85 ± 0.76	0.45 ± 0.90	0.44 ± 0.80	0.75 ± 1.00
9 months	0.88 ± 0.75	0.45 ± 0.76	0.46 ± 0.80	0.77 ± 0.90
1 year	0.88 ± 0.75	0.53 ± 0.90	0.47 ± 0.80	0.78 ± 0.90

Table 2 Summary of Recession Trends

Location	Mean recession (mm)	Sites showing recession (%)	Sites showing growth (%)	Sites showing no change (%)
Mesial	0.47	60	12	28
Distal	0.78	75	14	11
Buccal	0.88	82	6	12
Lingual	0.52	60	12	28

DISCUSSION

Of the myriad of factors that may influence the response of peri-implant gingival tissues, this study examined 4 specific categories: *(1)* maxillary versus mandibular tissue types, *(2)* the presence or absence of attached gingiva, *(3)* type of abutment (temporary healing abutment versus final abutment), and *(4)* fixed versus removable provisional restorations. Other factors which may also influence the peri-implant tissues include: type of implant used, angulation of the implant, surface properties of the implant, diameter of the implant, incision design at the abutment connection surgery, oral hygiene of the patient, and prosthesis design. These other factors need to be evaluated by future studies.

The results of this study clearly display a mean trend toward recession over the 1-year time period. By the third month, midbuccal recession progressed to 0.75 mm and then slowly increased to 0.85 mm by the end of 6 months and stayed at that level for the last 6 months. It was interesting to note the slight coronal migration of the tissue at 1 week postoperatively. The initial increase is most likely

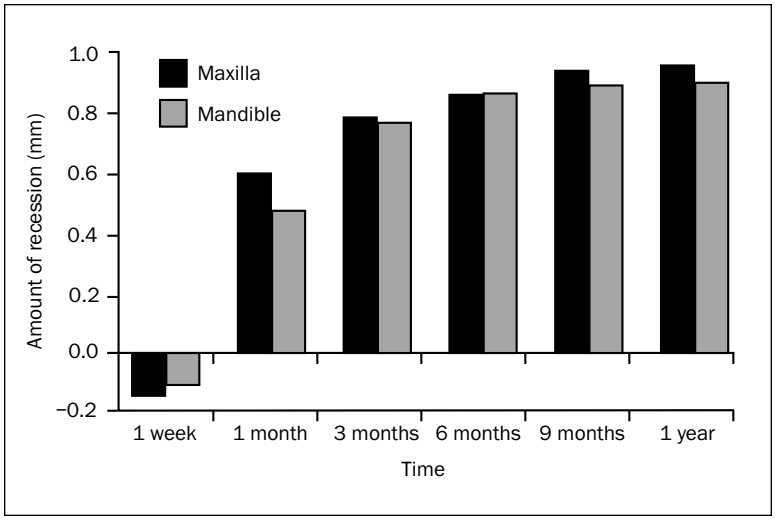

Fig 3 Comparison of maxillary and mandibular measurements of buccal recession.

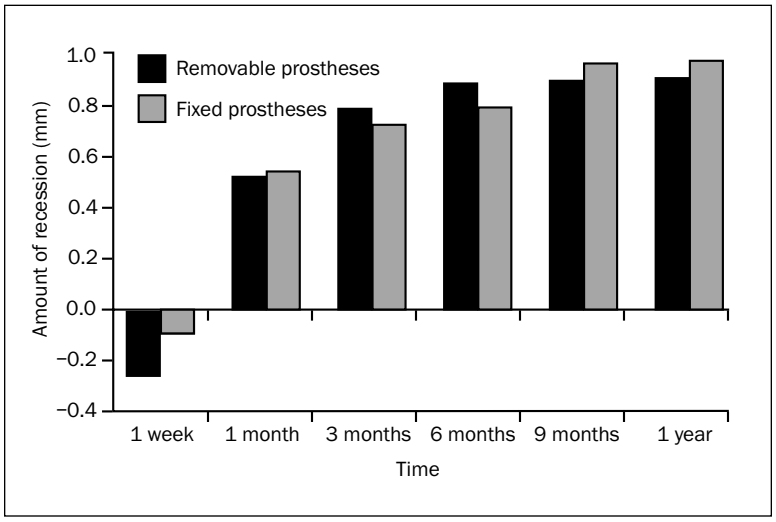

Fig 4 Comparison of measurements of buccal recession with respect to type of restoration (fixed partial denture versus removable partial denture).

the result of swelling or inflammation. This has potential clinical significance. If the restorative dentist makes an impression 1 week after stage 2 surgery, or selects an abutment based upon this tissue level, a poor esthetic outcome may result. From 1 week (–0.17 mm coronal growth) to 1 year (0.88 mm recession), the total mean recession on the midbuccal was greater than 1 mm (1.05 mm). Most of the recession occurred during the first 3 months following abutment connection surgery. For this reason, clinical protocols should take into account at least 1 mm of total recession. Therefore, in an esthetically demanding area, abutment selection and final impressions should be performed after at least 3 months of healing.

It is critical to note that although the mean recession was 0.88 mm on the midbuccal at 1 year, great variability existed. This variability was significant at all 4 locations around the implant or abutment.

Of all the mesial and distal sites that were examined, only a small portion exhibited coronal growth. This coronal growth could not be directly correlated to any of the clinical considerations evaluated in this investigation.

When the results of maxillary versus mandibular tissues were analyzed, maxillary recession was found to be greater than mandibular recession by 0.1 mm at each of the follow-up intervals. This was not statistically significant. The data comparing fixed versus removable provisional restorations showed an

increase in marginal tissue height in the first week beneath removable partial dentures only. This may have been the result of inflammation caused by the transitional removable partial denture over the implant sites. At the subsequent evaluations, the patients provisionalized with fixed partial dentures showed a greater tendency toward recession than those with removable provisional restorations, but these results were not statistically significant.

Some patients received temporary healing abutments at stage 2 surgery, while others had final abutments placed at that time; results from patients with 1-stage (ITI) implants were included with the latter for analysis. It was thought prior to the study that repeated manipulation of the temporary healing abutments during the course of prosthesis fabrication could cause increased recession because of continued disruption of the gingival attachment. However, the data neither supported nor disproved this notion. A larger sample size might yield a more definitive comparison.

The results of this study showed some notable differences versus the studies mentioned earlier in this report. In Adell et al,[7] the baseline measurement was obtained approximately 1 month after abutment connection surgery, as was the case with the study by Apse et al.[9] Bengazi et al[10] also used prosthesis placement as a baseline. This investigation recorded the baseline measurement at the time of abutment connection surgery. Adell et al[7] found a total of 1.7 mm of recession after 3 years and 1.3 mm recession from 1 month to 1 year. Apse et al[9] found 1.75 mm of recession from 1 month to completion of the study (4 to 9 years). Bengazi et al[10] found approximately 0.4 mm of recession at 6 months and approximately 0.5 mm recession at 2 years. The present study found a mean of 0.4 mm recession from the 1-month interval to 1 year. These differences may be attributed to the different percentages of attached gingiva present in the studies. Adell et al[7] recorded 65% attached gingiva, while Apse et al[9] reported 45% attached gingiva. Bengazi et al[10] found greater recession in sites without keratinized mucosa (approximately 0.65 mm) and slightly less recession in sites with keratinized mucosa (approximately 0.4 mm). The present study reports 98.6% attached gingiva. Within these data, this factor could not be comparatively analyzed, since such a high percentage of sites were surrounded with attached gingiva. As stated in the results, maxillary and mandibular tissues responded similarly, and the type of provisional restoration and the type of abutment used did not result in statistically significantly different outcomes.

CONCLUSION

Buccal recession around implants has potentially important clinical implications. This study illustrates clear trends in soft tissue behavior. The majority of recession occurred within the first 3 months, and 80% of all sites on the buccal exhibited recession. It is therefore recommended that 3 months elapse for the tissue to stabilize before either selecting a final abutment or making final impressions. As a general rule, approximately 1 mm of recession can be anticipated from the time of abutment connection surgery. Further research is needed with a larger sample size so that each of the many other variables not tested in this study can be evaluated and greater understanding of the soft tissue can be achieved.

ACKNOWLEDGMENTS

The authors thank Dr John Legaros for his expert assistance with the statistical analysis.

REFERENCES

1. James RA, Shultz RL. Hemidesmosomes and the adhesion of junctional epithelial cells to metal implants. A preliminary report. Oral Implantol 1974;4:294–302.
2. Gould TRL, Brunnette DM, Westbury L. The attachment mechanism of epithelial cells to titanium in vitro. J Periodont Res 1981;16:611–616.
3. Lavelle CLB. Mucosal seal around endosseous dental implants. J Oral Implantol 1981;9:357–371.
4. Jansen JA. Ultrastructural study of epithelial cell attachment to implant materials. J Dent Res 1985;64:891–896.
5. Toth RW, Parr GR, Gardner LK. Soft tissue response to endosseous titanium oral implants. J Prosthet Dent 1985;54: 564–567.
6. Brånemark P-I, Hansson O, Adell R, Breine U, Lindstrom J, Hallén O, Ohman A. Osseointegrated implants in the treatment of the edentulous jaw: Experiences from a 10-year period. Scand J Plast Reconstr Surg 1977;11(suppl 16).
7. Adell R, Lekholm U, Rockler B, Brånemark P-I, Lindhe J, Eriksson B, Sbordone L. Marginal tissue reactions at osseointegrated titanium fixtures. (I). A 3-year longitudinal prospective study. Int J Oral Maxillofac Surg 1986;15:39–52.
8. Lekholm U, Adell R, Brånemark P-I, Lindhe J, Rockler B, Eriksson B, et al. Marginal tissue reactions at osseointegrated titanium fixtures (II). A cross-sectional retrospective study. Int J Oral Maxillofac Surg 1986;15:53–61.
9. Apse P, Zarb GA, Schmitt A, Lewis DW. The longitudinal effectiveness of osseointegrated dental implants. The Toronto study: Peri-implant mucosal response. Int J Periodontics Restorative Dent 1991;11(2):94–111.
10. Bengazi F, Wennstrom JL, Lekholm U. Recession of the soft tissue margin at oral implants. A 2-year longitudinal prospective study. Clin Oral Implants Res 1996;7:303–310.