

Retention of Hopeless Teeth: The Effect on the Adjacent Proximal Bone Following Periodontal Surgery

Eli E. Machtei*† and Ilan Hirsch*

Background: Clinical wisdom often suggests that retention of periodontally hopeless teeth may accelerate the destruction of the adjacent periodontium. The purpose of this study was to examine the effect of retaining hopeless teeth on the adjacent alveolar bone following periodontal surgery.

Methods: A retrospective study was conducted based on intraoral radiographs. Teeth were considered hopeless if they had lost $\geq 70\%$ bone height at either of the proximal surfaces. The minimal follow-up period after surgery was 24 months. All subjects completed periodontal therapy, including scaling and root planing (SRP), and periodontal surgery at these sites. Ninety-three subjects with 110 hopeless teeth were included in this study. Cases were sorted into two groups: retained, which included 57 hopeless teeth (50 subjects) that were maintained; and extracted, which included 53 hopeless teeth (43 subjects) that were removed at surgery. All radiographs were digitized, and measurements of radiographic bone distance (RBD) were made using computerized software.

Results: Mean follow-up was 4.40 ± 0.23 years. For the retained hopeless teeth, there was a mean bone gain of 0.82 mm from baseline (7.18 ± 0.35 mm) to the final examination (6.45 ± 0.41 mm; $P = 0.0061$). Likewise, the postoperative percentage of RBD of the retained hopeless teeth showed a statistically significant improvement from baseline ($57.46\% \pm 1.5\%$) to the final examination ($52.32\% \pm 2.03\%$; $P = 0.0032$). Teeth adjacent to a hopeless tooth had a slight radiographic bone gain postoperatively, which was greater in the extracted group. However, it was significant only for the distal neighboring teeth (1.50% versus 11.36%, respectively; $P = 0.0119$).

Conclusion: Long-term preservation of hopeless teeth following periodontal surgery is an attainable goal with no detrimental effect on the adjacent proximal teeth. *J Periodontol* 2007;78:2246-2252.

KEY WORDS

Bone loss; periodontitis; retention; surgery.

The prevalence of periodontal disease in humans is high, with 10% to 15% of patients exhibiting the severe form of the disease.^{1,2} Studies³⁻⁵ have demonstrated periodontal disease to be one of the main causes of tooth loss worldwide. Lower rates of tooth mortality in periodontally treated patients can be achieved: Hirschfeld and Wasserman⁶ examined the periodontal status of subjects who had been treated for periodontal disease and subsequently maintained for 22 years or more in a specialist practice. They found that 7.1% of all teeth were extracted for periodontal reasons. Comparable long-term studies of tooth loss from patients treated in specialist practices by McFall⁷ and Goldman et al.⁸ reported higher overall tooth loss (10% and 13.4%, respectively) during a maintenance period >15 years. These studies⁶⁻⁸ showed that molar teeth are the most likely to be lost, whereas the mandibular cuspid is the least likely to be lost. The rate of tooth loss and attachment loss (AL) in untreated populations or in treated subjects not following a regular maintenance care therapy is much higher: Löe et al.⁹ reported a mean annual AL ~ 0.1 mm in a well-maintained Norwegian population compared to 0.2 to 0.3 mm in an untreated group of tea plantation workers from Sri Lanka. Becker et al.¹⁰ reported a loss of 0.61 teeth per subject per year over a 3.7-year period in an untreated population, whereas Nabers et al.¹¹ reported a

* Unit of Periodontology, Department of Oral and Dental Medicine, Rambam Health Care Campus, Haifa, Israel.

† Faculty of Medicine, Technion, Haifa, Israel.

much lower rate of 0.29 teeth per subject per year over an average 13-year period.

The anticipated prognosis of any tooth is likely to affect treatment planning; thus, the practice of extracting hopeless teeth is based on the assumption that its retention might result in continuous AL for the hopeless tooth and its proximal neighbors. Thus, the methodology of “strategic extractions” (the extraction of hopeless teeth to prevent continuing bone loss at adjacent teeth) has evolved.¹²⁻¹⁴ However, newer information¹⁵ about the episodic nature of periodontal disease may question the validity of this approach.

Several studies have investigated the effect of retaining hopeless teeth on the adjacent periodontium. Machtei et al.¹⁶ investigated the alveolar bone changes adjacent to hopeless teeth, with and without extraction, in a sample of 145 teeth from 129 subjects in whom periodontal treatment was absent. Teeth were considered hopeless if they had lost $\geq 50\%$ bone height at either proximal site or had radiographic evidence of “through and through” bone loss in the furcation area. Results 4 years later revealed significantly greater annual bone loss adjacent to retained hopeless teeth than adjacent to hopeless teeth that were extracted (3.12% versus 0.23%, respectively). Other studies^{17,18} demonstrated that surgical removal of the mandibular third molar in subjects who received no periodontal treatment may lead to a periodontal breakdown on the distal surface of the second molar.

By contrast, in a retrospective study, DeVore et al.¹⁹ evaluated the periodontal status of 17 teeth adjacent to one hopeless tooth. Teeth were characterized as hopeless if they presented with two or more of the following criteria: loss of 75% of the supporting bone; probing depth (PD) > 8 mm; Class 3 furcation involvement or mobility; poor crown/root ratios; root proximity; and a history of periodontal abscess. All teeth received surgical periodontal treatment that included osseous resection and were followed for a mean of 3.5 years. The investigators concluded that retention of periodontally hopeless teeth had no detrimental effect on the proximal periodontium of adjacent teeth prior to and following treatment. In a follow-up report,²⁰ these investigators presented further validation of the results 8 years postoperatively.

The purpose of the present study was to compare the long-term effect of extracting or maintaining hopeless teeth on the alveolar bone height of the adjacent teeth.

MATERIALS AND METHODS

This retrospective study was conducted at the Department of Periodontology and Oral-Dental Medicine, Rambam Health Care Campus in accordance with the Helsinki Declaration of 1975, as revised in 2000. The study was based on periapical radiographs

obtained from the subjects' files. Files of patients treated between 1990 and 2003 were screened for this study. Subjects were enrolled consecutively until there were ≥ 40 participants in each group. Subjects were included in the study if they met all of the following inclusion criteria: a periapical radiograph showing the presence of at least one hopeless tooth and its proximal neighbors; follow-up radiographs taken ≥ 24 months postoperatively; non-smokers with no contributory systemic diseases; and a pretreatment diagnosis of localized or generalized severe chronic periodontitis. Teeth were considered hopeless if they had radiographic bone loss $\geq 70\%$ at either of their proximal sites.

Initially, all participants received hygiene-phase therapy. Following this phase of treatment, subjects were reevaluated, and only those subjects with insufficient response (PD > 6 mm) were subjected to a surgical flap debridement procedure performed by a single operator (EEM). Upon completion of active treatment, subjects were reexamined (reevaluation 2) and placed into a proper maintenance protocol. Subjects attended maintenance therapy every 3 to 6 months, which included oral hygiene reinforcement and scaling. A total of 110 teeth from 93 subjects were included in this study. Cases were sorted into two groups: retained, which included 57 hopeless teeth (from 50 subjects) that were maintained at the time of the surgery and thereafter (Fig. 1); and extracted, which consisted of 53 hopeless teeth (from 43 subjects) that were removed at the time of the surgery (Fig. 2).

The decision about whether to extract or maintain the hopeless teeth was left entirely to the subject, without any influence or contribution from the operator performing the procedure.

All radiographs were digitized using an advanced radiographic scanner.[‡] Measurements of linear distances were performed on the digital images by a single examiner (IH), using custom-made software.[§] Root length was measured from the root apex to the cemento-enamel junction; bone height was measured from the root apex to the alveolar crest; radiographic bone distance (RBD) was calculated as the difference between the above measurements. Bone loss was defined as the difference between RBD preoperatively and RBD postoperatively (positive values represented bone gain), and the percentage of RBD was calculated as (RBD/root length) $\times 100$. Results were recorded and grouped, and means and standard errors were calculated.

Statistical Analysis

Changes in RBD from baseline to the end of the follow-up period were calculated for each group independently using the Student *t* test for paired observations.

‡ Canonscan 3000f, Canon, Tokyo, Japan.

§ Virtual Measuring Tape, Virtual Measurements, Tel Aviv, Israel.

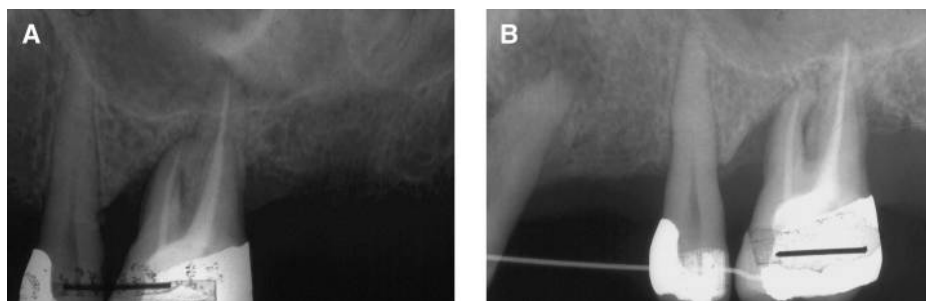


Figure 1.

A) Preoperative radiograph of hopeless tooth #14. **B)** The radiographic bone height on adjacent tooth #13 is almost unchanged from baseline at 7 years postoperatively.

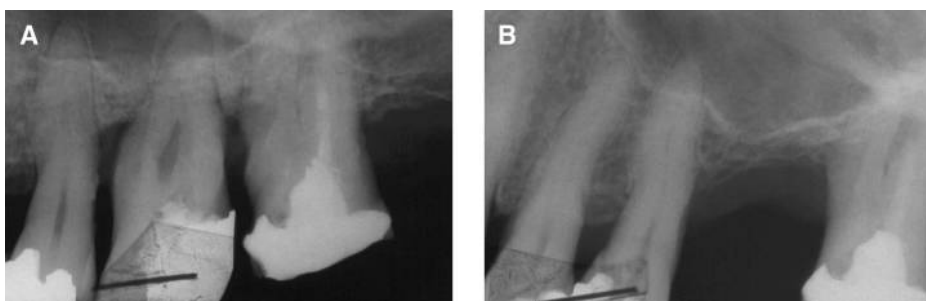


Figure 2.

A) Periapical radiograph of tooth #14 preoperatively. The tooth was removed at the time of surgery. **B)** Neighboring teeth #13 and #15 exhibit minimal or no radiographic bone loss at 5 years postoperatively.

Changes in RBD between the groups (retained versus extracted) were compared using the two-tailed Student *t* test for unpaired observations. A 5% significance level was chosen.

RESULTS

Ninety-three subjects (59 females and 34 males) with 110 hopeless teeth were included in this study. Subjects were followed for 2 to 13 years (mean, 4.40 ± 0.23 [SD] years). Ages ranged from 16 to 68 years (mean, 45.54 ± 1.13 [SD] years). Of the retained teeth, 31 were multirooted, and 26 were single-rooted; of the extracted teeth, 43 were multirooted, and 10 were single-rooted. Approximately two-thirds of these teeth were maxillary (both groups).

Table 1 compares the preoperative radiographic parameters between groups. The preoperative mean RBD was very similar for the extracted (7.25 ± 0.39 [SE] mm) and retained (7.18 ± 0.35 [SE] mm) groups ($P = 0.8841$). Similarly, the mean percentage of RBD for the extracted (60.08% ± 1.88% [SE]) and retained (57.46% ± 1.50% [SE]) groups did not differ significantly ($P = 0.1642$). Likewise, the preoperative RBD of teeth adjacent to hopeless ones did not differ between groups: 5.68 ± 0.35 (SE) mm versus 5.25 ±

0.35 (SE) mm for the mesial neighbor of the retained and extracted teeth, respectively ($P = 0.4015$), and 5.46 ± 0.35 (SE) mm versus 5.41 ± 0.51 (SE) mm for the distal neighbor of the retained and extracted teeth, respectively ($P = 0.9321$).

The postoperative radiographic parameters are shown in Table 2. The postoperative RBD of the teeth adjacent to the hopeless teeth did not differ between groups: 5.40 ± 0.44 (SE) mm versus 4.63 ± 0.33 (SE) mm for the mesial neighbor of retained and extracted teeth, respectively ($P = 0.1717$), and 5.17 ± 0.39 (SE) mm versus 4.44 ± 0.45 (SE) mm for the distal neighbor of retained and extracted teeth, respectively ($P = 0.781$).

Changes in the radiographic parameters from baseline to the final examination for the retained group are given in Table 3. Postoperatively, there was a mean radiographic bone gain (RBG) on the mesial (1.1 ±

0.35 [SE] mm) and distal (0.83 ± 0.33 [SE] mm) aspects of retained hopeless teeth ($P = 0.0032$ and 0.0164, respectively). For the adjacent proximal teeth (mesial and distal), there was a slight RBG (~0.3 mm) compared to baseline; however, these differences were not statistically significant.

Table 4 compares the changes in RBD of neighboring teeth between the two groups. In general, there was greater RBG for adjacent teeth in the extracted group compared to the retained group (0.71 ± 0.33 [SE] mm and 0.28 ± 0.34 [SE] mm for the mesial teeth and 1.14 ± 0.40 [SE] mm and 0.29 ± 0.31 [SE] mm for the distal teeth); however, these differences did not reach statistical significance ($P > 0.05$). The percentage of RBG at the distal neighboring teeth was 11.36% ± 3.30% SE in the extracted group compared to 1.50% ± 2.1% SE in the retained group; these differences were statistically significant ($P = 0.0119$).

DISCUSSION

In the present study, the retained hopeless teeth had slight bone gain following periodontal surgery. Devore et al.,¹⁹ who evaluated mesial surfaces adjacent to 17 hopeless teeth and compared them to non-adjacent surfaces, reported similar findings, i.e., no differences

Table 1.
Preoperative Radiographic Parameters

Variable	Retained (mean ± SE)	Extracted (mean ± SE)	P Value
RBD hopeless teeth (mm)	7.18 ± 0.35	7.25 ± 0.39	0.8841
RBD hopeless teeth (%)	60.08 ± 1.88	57.46 ± 1.50	0.1642
RBD adjacent mesial teeth (mm)	5.68 ± 0.35	5.25 ± 0.35	0.4015
RBD adjacent mesial teeth (%)	42.44 ± 2.33	41.49 ± 2.35	0.7741
RBD adjacent distal teeth (mm)	5.46 ± 0.35	5.41 ± 0.51	0.9321
RBD adjacent distal teeth (%)	41.64 ± 2.07	46.08 ± 3.46	0.2483

Table 2.
Postoperative Radiographic Parameters

Variable	Retained (mean ± SE)	Extracted (mean ± SE)	P Value
RBD hopeless teeth (mm)	6.46 ± 0.41	–	–
RBD hopeless teeth (%)	52.32 ± 2.03	–	–
RBD adjacent mesial teeth (mm)	5.40 ± 0.44	4.63 ± 0.33	0.1717
RBD adjacent mesial teeth (%)	40.56 ± 3.20	39.41 ± 2.55	0.2672
RBD adjacent distal teeth (mm)	5.17 ± 0.39	4.44 ± 0.45	0.781
RBD adjacent distal teeth (%)	40.15 ± 2.30	36.04 ± 3.62	0.3253

– = not applicable.

in PD and bone loss between groups, whereas there was a significant reduction in the mean PD for the adjacent surfaces from pretherapy to post-surgery (from 4 mm to 3 mm). A follow-up report²⁰ 8.4 years postoperatively published by the same authors confirmed their previous findings. A major disadvantage of the above two studies was the small sample (only 17 subjects, of whom 15 underwent surgical treatment¹⁹); even more importantly, only 10 subjects from the original sample were included in the follow-up study. To the contrary, in our previous study,¹⁶ we reported that the retention of hopeless teeth had a negative effect on their proximal neighbors. However, the lack of any periodontal treatment in this earlier study likely accounted for the continuous bone loss that was observed.

The present study showed that periodontal surgery inhibited further bone loss and resulted in slight RBG for the hopeless teeth (0.82 ± 0.34 mm). Several factors may explain these results; the most important factor was the subject's plaque control and strict main-

tenance program. In a long-term maintenance study of subjects treated for advanced periodontitis, Lindhe and Nyman²¹ reported that subjects' mean PD, AL, and RBD did not progress significantly over a 14-year period. Likewise, Svardstrom and Wennstrom,²² in a similar 10-year longitudinal study, reported minimal annual radiographic bone loss (0.01 to 0.06 mm) in molars treated for furcation involvement.

Smoking is another major risk factor for periodontal disease progression.^{23,24} Grossi et al.^{25,26} found that heavy smokers had greater odd ratios for attachment and alveolar bone loss compared to non-smokers. It was shown that smoking affected the response of non-surgical and surgical periodontal treatment.²⁷⁻²⁹ The exclusion of smokers from the present study might have resulted in greater bone gain postoperatively. This is consistent with the study by Ah et al.,³⁰ who reported that smokers exhibited significantly less reduction in PD and less gain of probing attachment level compared to non-smokers following surgical and non-surgical therapy over a maintenance period of 6 years.

The results of the present study showed that the retention of hopeless teeth did not exert any detrimental effect on the adjacent proximal teeth. Nonetheless, teeth adjacent to hopeless teeth that were extracted had slightly greater RBG compared to those adjacent to retained teeth; however, these differences were statistically significant only for the distal neighbors of the hopeless teeth that were extracted compared to retained ones ($1.5\% \pm 2.1\%$ versus $11.36\% \pm 3.3\%$, respectively). This can be attributed to the larger sample size of teeth with available distal aspects for measurement ($n = 96$) compared to mesial aspects ($n = 74$). Likewise, the effect of surgical removal of mandibular third molars on the RBD of the adjacent second molars was reported recently.³¹ A significant RBG was observed at the treated (extracted) sites, whereas slight bone loss was reported for the non-extracted controls.

Non-standardized periapical radiographs were used in the present study. Although standardized radiographs have greater accuracy,³² Merchant et al.³³ showed that non-standardized radiographs can still

Table 3.**Changes in Radiographic Parameters of Retained Hopeless Teeth From Baseline to Final Examination**

Variable	Preoperative (mean ± SE)	Postoperative (mean ± SE)	Change ± SE*	P Value
RBD hopeless teeth (mm)	7.18 ± 0.35	6.45 ± 0.41	0.82 ± 0.34	0.0061
RBD hopeless teeth (%)	57.46 ± 1.49	52.32 ± 2.03	5.94 ± 2.12	0.0032
RBD adjacent mesial teeth (mm)	5.68 ± 0.36	5.40 ± 0.44	0.28 ± 0.23	0.422
RBD adjacent mesial teeth (%)	42.45 ± 2.33	40.56 ± 3.21	1.88 ± 1.92	0.5384
RBD adjacent distal teeth (mm)	5.46 ± 0.35	5.17 ± 0.40	0.29 ± 0.25	0.3673
RBD adjacent distal teeth (%)	41.65 ± 2.07	40.15 ± 2.30	1.50 ± 1.85	0.4811

* Positive numbers represent bone gain.

Table 4.**Changes in Radiographic Bone Height of the Neighboring Teeth: Comparison Between Groups***

Variable	Retained (mean ± SE)	Extracted (mean ± SE)	P Value
Changes in RBD of the mesial neighboring teeth (mm)	0.28 ± 0.34	0.71 ± 0.33	0.36
Changes in RBD of the mesial neighboring teeth (%)	1.88 ± 3.04	2.57 ± 2.36	0.8605
Changes in RBD of the distal neighboring teeth (mm)	0.29 ± 0.31	1.14 ± 0.40	0.1175
Changes in RBD of the distal neighboring teeth (%)	1.50 ± 2.10	11.36 ± 3.3	0.0119

* Positive numbers represent bone gain.

be a useful tool to assess radiographic bone changes in longitudinal studies.

Furthermore, the use of the percentage of bone gain/loss as a surrogate outcome variable (in addition to bone loss/gain in millimeters) and the similarity of the changes using both variables helped to validate our findings.

Data on the survival rates of the retained hopeless teeth were not available in this analysis, which requires some caution. Nonetheless, several longitudinal, long-term studies have examined the survival of severely compromised teeth following periodontal treatment. Earlier studies^{6,7} reported that a relatively large percentage of these teeth were lost following therapy. However, many of the subjects in these studies received only SRP as their active treatment. Recently, Harrel and Nunn³⁴ compared different treatment modalities for advanced periodontitis using a site-/tooth-based analysis. They concluded that teeth receiving no treatment or SRP only showed further disease progression, whereas surgically treated sites showed significant improvement in PD. More recent

studies have shown much greater survival rates with surgical periodontal treatment. In a longitudinal study³⁵ of furcation-involved molars, Carnevale et al. reported a 10-year survival rate of 93% to 99% following surgical treatment. The factors affecting the long-term survival of questionable and hopeless teeth was studied recently by several groups using a logistic regression analysis.^{36,37} Baseline periodontal breakdown was not identified by the model, whereas age, smoking, oral hygiene, and time since conclusion of active treatment were included and accounted for most of the variation.

Of the 74 multirrooted hopeless teeth, 43 were extracted, and 31 were retained, whereas only 10 of the 36 hopeless single-rooted teeth were extracted. The subjects' preference of tooth retention in the anterior dentition is likely due to the initial esthetic impact that such extraction might have in these sites. Nonetheless, one should keep this in mind when considering these data.

Finally, over the last decades, dental implants have become a common treatment alternative for periodontally compromised teeth. With a survival rate

>90% over 5 and 10 years,^{38,39} many clinicians tend to prefer the extraction of hopeless teeth and replacement with dental implants.⁴⁰ The results of the present study and more recent reports on the survival rate of these teeth, therefore, would invite a revision of this trend in favor of saving and maintaining questionable and hopeless teeth.

CONCLUSIONS

Within the limitations of the study, it seems that long-term preservation of hopeless teeth following periodontal surgery is an attainable goal with no detrimental effect on the neighboring teeth. However, results should be interpreted with caution, and each case must be dealt with separately. Prospective longitudinal studies involving larger sample sizes and combining radiologic and clinical parameters are necessary to substantiate the evidence of the present study.

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Correspondence: Dr. Eli E. Machtei, Department of Oral and Dental Medicine and Unit of Periodontology, Rambam Health Care Campus, P.O. Box 9602, Haifa 31096, Israel. Fax: 972-4-854-3057; e-mail: machtei@rambam.health.gov.il.

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