Removal of Amalgam Overhangs

A Profilometric and Scanning Electron Microscopic Evaluation

by

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SUBGINGIVAL RESTORATIONS with overhanging margins are associated with gingival inflammation and loss of attachment, as demonstrated by histological[1-4] and epidemiological studies.[5-10] Even subgingivally well adapted restorations enhance an inflammatory periodontal response[11, 12] apparently caused by bacterial plaque rather than by chemical or mechanical irritation from the restorative material per se.[13]

A high prevalence of overhanging margins associated with subgingival restorations has been reported.[7]

Trimmers, chisels, surgical blades and reciprocating motor-driven diamond tips, are among the instruments used to remove overhangs as part of the hygienic phase of periodontal treatment. The purpose of the present study was to assess *in vitro* the effectiveness of these four different instruments in the removal of overhangs from amalgam restorations.

MATERIALS AND METHODS

Forty recently extracted human teeth, kept in a solution of alcohol 96% and glycerine (1:1), were selected for this study. The teeth had Class II amalgam restorations with overhangs which were detectable clinically by a No. 3 cowhorn explorer.

The teeth were mounted in plaster casts, and randomly assigned to four different groups of 10 teeth each. Amalgam overhangs were removed, using one of the following instruments for each group: (1) Rhein Trimmer No. 31-32,§ (2) Chisel No. 24-25, ‖ (3) No. 12 Surgical blade,¶ (4) Reciprocating-motor-driven diamond tip.**

These instruments were used by the same operator, until the overhangs were clinically undetectable. Upon completion, a second operator checked the smoothness of the treated areas by means of a No. 3 explorer.

The smoothness of the tooth-amalgam interface was then examined on each specimen by means of a surface measuring instrument, SURFANALYZER model 150 Drive, equipped with a calibrated probe, model 21-3100-00 running at a constant speed and providing a gauging system. The probe output was recorded revealing the surface profile of the tooth-amalgam interface with magnifications of 100 horizontally and 1000 vertically.

The tooth was horizontally positioned with the instrumented area facing up. The probe always ran perpendicularly to the long axis of the tooth, from tooth to restoration and with a constant pressure of 100 mg. Four tracings from each specimen were recorded. These tracings recorded the profile of the interface. Thus, by measuring the vertical discrepancy at the tooth-restoration interface and recording it on the calibrated paper, the effectiveness of the instruments to remove the overhangs could be assessed.

The average of the readings for each experimental specimen was determined which provided the mean profile score for the particular tooth. A mean for each instrument was also obtained by averaging the individual mean profile scores of the ten teeth in each group. The results were subjected to statistical evaluation.

After the profile scores were obtained, the teeth were dehydrated, mounted on plastic stubs, and coated with gold-palladium alloy†† in a coating unit. The tooth-restoration interfaces were then observed under the scanning electron microscope (Super II).†† The interfaces were photographed at 140 magnification, adjusting the beam-specimen angulation to provide the best visual field.

RESULTS

The mean profile scores recorded for the teeth varied from 1 μm to 4 μm in the four groups (ranging for individual tracings from -2 to 6 μm). Those values are indicative of the severity of the overhangs left after instrumentation at the tooth-restoration interface. In other words, this is the mean discrepancy measured in a mesio-distal direction between the approximal root surface and the approximal surface of the amalgam. Table 1 shows the number of teeth and percentages according to the mean discrepancy recorded and the instrument used. The chisel was responsible for 75% of those treated teeth showing the highest discrepancy, whereas the reciprocating motor-driven diamond tip treatment was used for 55% of those teeth that showed the least discrepancy. A Chi square test showed significant differences among the results obtained with the different instruments ($P < 0.05$). An analysis of variance was

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§ S. S. White—Tarno.

‖ American Dental Manufacturing Company.

¶ Bard Parker.

** Eva Prophylaxis System, Unitek Manufacturing Company.

†† International Scientific Instruments, Mountain View, Calif.

TABLE 1. *Number of Teeth (and Percentages) According to the Mean Discrepancy (Overhang) Recorded After Instrumentation and the Instrument Used*

Inst. \ um	1		2		3		4		
	#	%	#	%	#	%	#	%	Total
Chisel	0	0.0	2	11.8	5	50.0	3	75.0	10
Trimmer	2	22.2	5	29.4	2	20.0	1	25.0	10
Blade	2	22.2	6	35.3	2	20.0	0	0.0	10
EVA	5	55.6	4	23.5	1	10.0	0	0.0	10
Total	9	100.0	17	100.0	10	100.0	4	100.0	40

Chi Square: 17.325
D.F. = 9
Sig. = 0.0439

The chisel accounts for 75% of the teeth with the highest overhang left, while the EVA accounts for 55% of those with the least mean profile score.

performed to test the hypothesis that the mean discrepancy was the same for the four instruments tested (Table 2). This showed significant differences ($P = 0.0008$), and therefore Scheffe's method of multiple comparisons was used to test each of the pairwise differences in instruments at the 5% level of significance. Significant differences were found between the chisel and the surgical blade and between the chisel and the EVA, but none of the other pairwise comparisons were significant at the 0.05 level. Nonparametric analysis of the data was also performed with similar results.

Figures 1 to 4 show profile tracings and their corresponding SEM photographs representative of tooth-restoration interfaces after instrumentation with chisel, trimmer, surgical blade and EVA, respectively.

TABLE 2. *Results From the Analysis of Variance*

	$\bar{X}$	SD
Chisel	3.10	0.73
Trimmer	2.20	0.91
Blade	2.00	0.66
EVA	1.60	0.69

$F = 6.9330$.
$P = 0.0008$.
The means obtained for each instrument tested were used. They were computed by averaging the mean profile scores of the 10 teeth in each group. The difference is highly significant.

DISCUSSION

If it is assumed that the use of a No. 3 explorer represents an acceptable clinical mean to check for smoothness after instrumentation, all the instruments tested were effective clinically in removing amalgam overhangs.

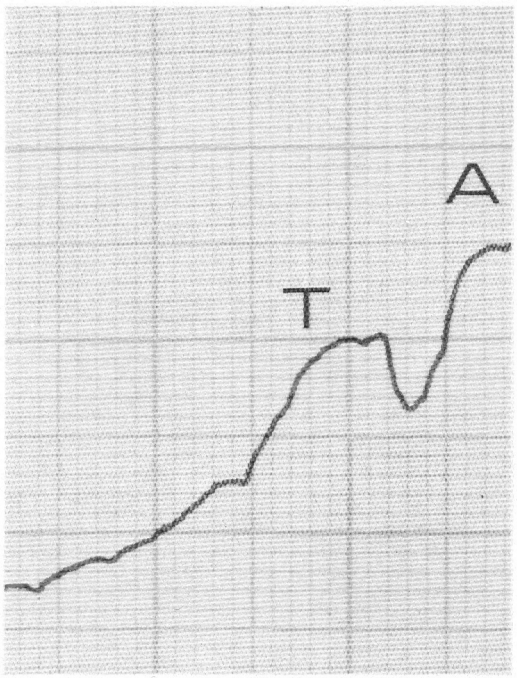
The results of the quantitative evaluation performed by means of profilometric tracings demonstrated, however, that there was a difference between profilometric and clinical assessments, since all samples showed some discrepancy. It is evident that an explorer although sharp, may fail to locate minute measurable irregularities due to its relatively bulky tip.

Overhangs of 0.2 mm or more have been correlated with interproximal bone loss.[7] It is interesting that all the mean discrepancies registered after instrumentation were far smaller in value. Thus, from a clinical standpoint, all instruments were effective in removing amalgam overhangs. The possibility exists of producing a reverse relationship at the tooth amalgam interface with instrumentation. This will create an "underhang" (Fig. 3, Top) which although probably easier to maintain, will also favor plaque retention.

Future *in vivo* evaluation of these procedures seems pertinent, to confirm the results of this *in vitro* study. However, it is reasonable to assume that due to problems of accessibility it may be even more difficult to remove overhangs *in situ* than on the bench. The purpose of the present study was only to compare the instruments tested on their effectiveness in removing amalgam overhangs in an *in vitro* situation.

As an additional finding the scanning electron microscope photographs revealed defects at the tooth-amalgam interface not perceived clinically but definitely detected through profilometric tracings (Figs. 1-4). All samples presented a gap or a void in that area. These gaps between tooth and restoration also have been reported in other scanning electron microscopic studies.[14-16] In the present sample these gaps ranged from 10 to 50 μm. According to previous studies, voids of this magnitude are not clinically detectable by visual inspection or by probing with a sharp explorer.[14, 15] These defects in the cervical adaptation of restorations have been related to problems such as: enamel and/or amalgam fractures, dimensional changes of the amalgam which alter its adaptation to the cavity walls[14] and poor condensation of the material.[15]

However, it should be understood that as part of the preparation of the samples for scanning electron microscopic observation, it is necessary to dehydrate the specimens. This could cause dimensional alterations which might produce the gaps, although this type of defect has been reported in both fresh and desiccated teeth.[16] The



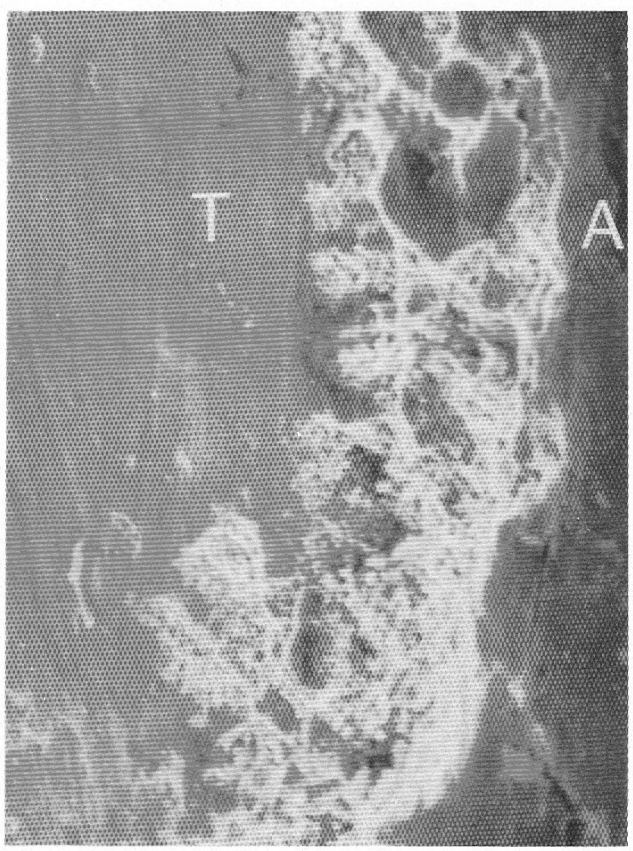
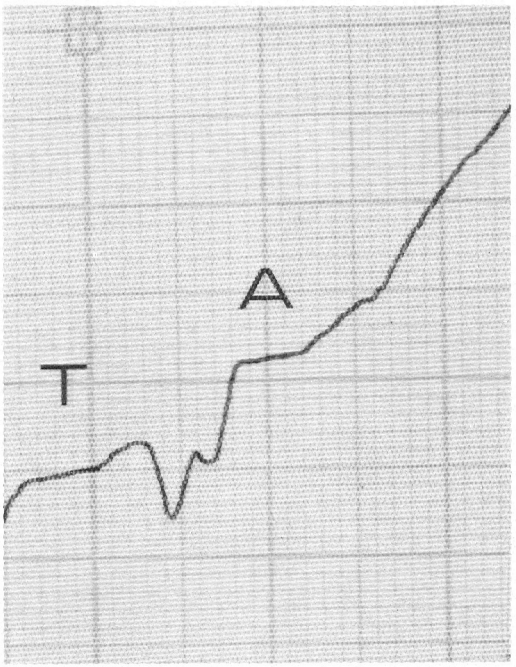


FIGURE 1. Top: *Profilometric recording representative of an individual tracing obtained after the use of a chisel. Note that the distance between two horizontal lines represents 1 μm, while that between two vertical lines equals 10 μm. A vertical discrepancy of 5 μm is noted between the tooth* (T) *and the amalgam* (A). *This represents the overhang left. There is also a 30 μm gap at the interface.* Bottom: *Scanning photomicrograph of the same tooth-amalgam interface left by the chisel (Original magnification, × 140).*



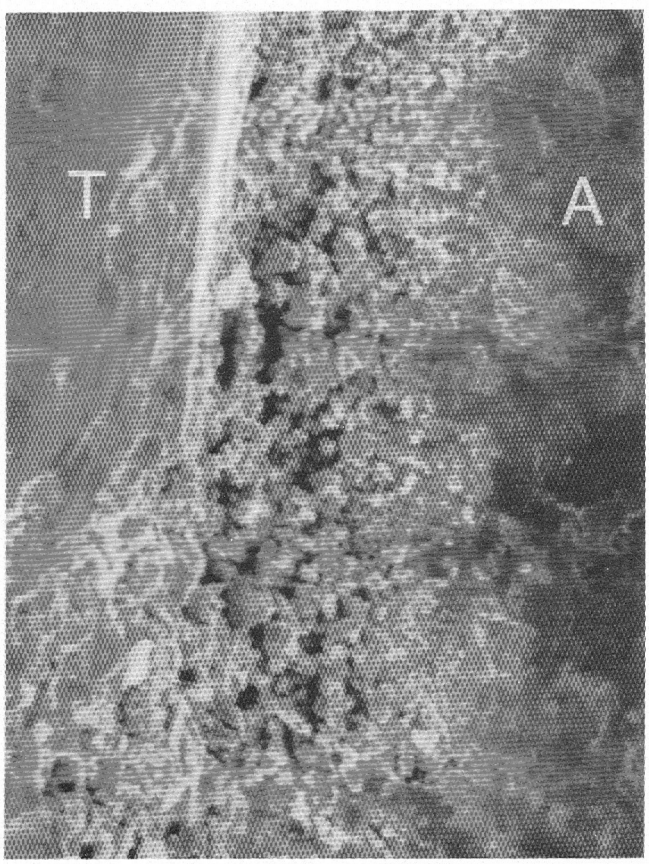
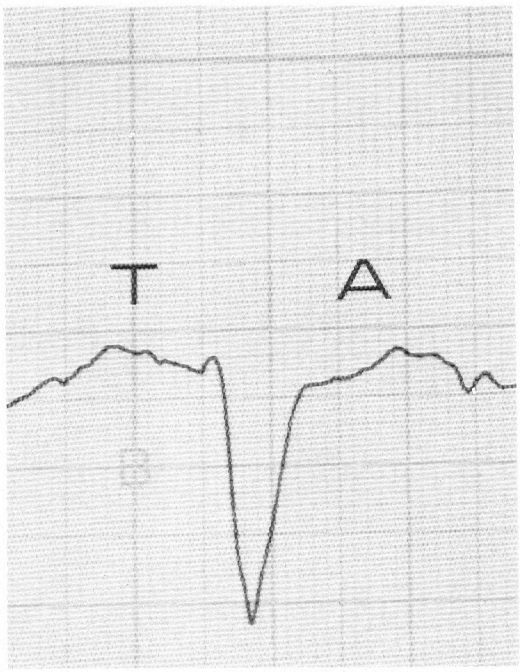


FIGURE 2. Top: *Individual profilometric tracing after the use of a trimmer. The vertical discrepancy (overhang) recorded between the tooth* (T) *and the amalgam* (A) *is 4 μm. The gap at the interface is 40 μm (distance between horizontal lines 1 μm, and between vertical lines 10 μm).* Bottom: *Scanning photomicrograph of the same tooth-amalgam interface left by the trimmer (Original magnification, × 140).*

J. Periodontol.
May, 1979



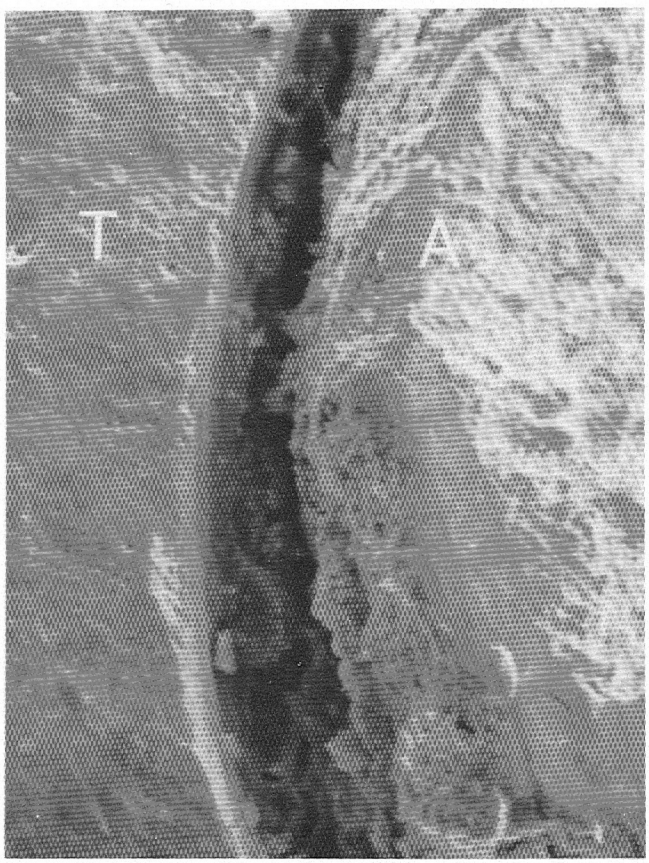
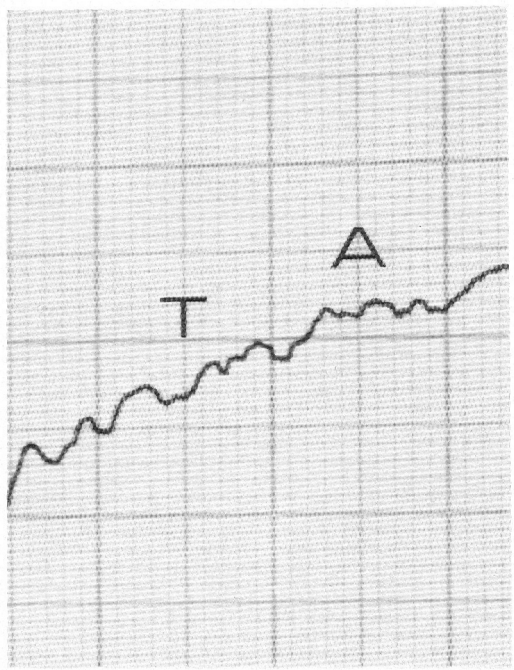


FIGURE 3. Top: *Individual profilometric recording after instrumentation with a surgical blade. The discrepancy noted between the tooth* (T) *and the amalgam* (A) *is 2 μm. However, in this instance a reverse relationship was established since the amalgam was removed beyond the tooth surface. An "underhang" was created. The gap at the interface is 50 μm (distance between horizontal lines 1 μm, and between vertical lines 10 μm).* Bottom: *Scanning photomicrograph of the same tooth-amalgam interface left by the surgical blade (Original magnification, × 140).*



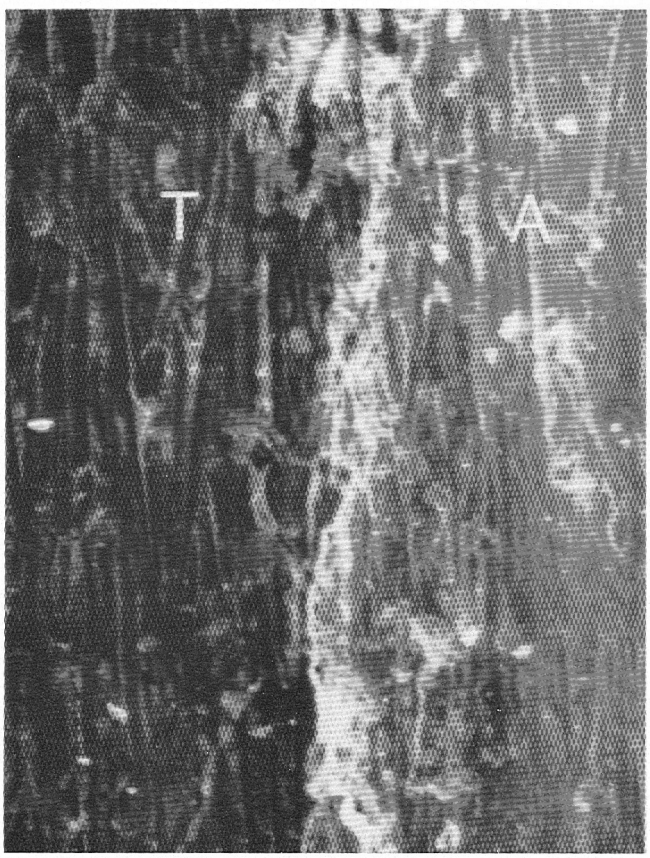


FIGURE 4. Top: *Individual profilometric tracing after instrumentation with a reciprocating motor-driven diamond tip. There is a discrepancy of less than 2 μm between the tooth* (T) *and the amalgam* (A), *which is similar to the irregularities left by instrumentation on the surfaces of both the tooth and the amalgam. A shallow gap 10 μm wide is noted at the interface (distance between horizontal lines 1 μm, and between vertical lines 10 μm).* Bottom: *Scanning photomicrograph of the same tooth-amalgam interface left by the EVA (Original magnification, × 140).*

potential for plaque retention in these gaps has been demonstrated.[15] Plaque will persist in these areas even after thorough oral hygiene procedures due to their inaccessability.

Summary

Forty recently extracted teeth with Class II amalgam restorations with overhangs were divided into four groups of 10 teeth each. The overhangs were removed using one of the following instruments in each group: trimmer, chisel, surgical blade and reciprocating motor-driven diamond tip. Instrumentation was performed until no irregularity could be detected clinically with a No. 3 explorer. The tooth-amalgam interfaces were examined by combined use of a surface measuring instrument and a scanning electron microscope.

Four tracings from each specimen were recorded and the discrepancy at the tooth-restoration interface was measured. The mean score for each tooth was determined, and the results were analyzed statistically. The tooth-restoration interfaces were photographed at 140 magnification with the SEM.

The results indicated that all instruments tested were effective in removing overhangs, since none of the mean discrepancies registered after instrumentation exceeded 4 μm. The surgical blade, and especially the reciprocating motor-driven diamond tip eliminated overhangs better than the chisel. Both SEM photographs and the profilometric tracings revealed gaps or voids at the tooth-amalgam interface, ranging from 10 to 50 μm.

Acknowledgments

We are grateful to Ronald A. Yapp for his technical assistance.

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