

A clinical evaluation of polished and unpolished amalgams: 36-month results

Lloyd H. Straffon, DDS, MS Richard E. Corpron, DDS, MS, PhD
Joseph B. Dennison, DDS, MS Susan H. Carron, DDS, MS
Kamal Asgar, BS, MS, PhD

Abstract

Twenty-six patients, 5-13 years of age, demonstrated 67 pairs of contralateral occlusal and buccal or lingual pit and fissure cavities which were restored with a spherical, high copper amalgam. One restoration of each pair was allowed to remain as carved, while the other was finished and polished conventionally 24 hours after insertion. Each restoration was evaluated clinically by three independent examiners. Black and white photographs were taken at baseline, 6, 18, and 36 months for a comparative indirect evaluation.

Clinically, margin adaptation became more detectable from baseline to 36 months for both the carved-only and the polished restorations, with no significant difference observed between the two methods of finishing.

Photographically, marginal adaptation showed significant deterioration from baseline to 36 months for both methods. Only from baseline to 6 months were the carved-only margins significantly better than the polished margins and this was demonstrated only with the photographic analysis. The surface texture was significantly different between carved-only and polished restorations at all recall evaluations but by 36 months the carved-only restorations were significantly smoother than they were at baseline.

The high copper dental amalgam alloys exhibit improved physical properties and handling characteristics in comparison to conventional dental amalgams. Improved marginal adaptation, increased resistance to surface corrosion, and lower static creep are examples of improvements that are documented in current texts.¹

Reports have stated that marginal adaptation and resistance to surface corrosion are enhanced by post-insertion finishing and polishing techniques.²⁻⁴ However, frequent marginal gaps have been evident between the amalgam and the cavosurface enamel

margin following the application of accepted finishing and polishing techniques.⁵⁻⁸

The aim of this study was to compare high copper amalgam restorations which were allowed to remain as carved with similar restorations that were finished and polished after a postinsertion period of at least 24 hours. Written criteria for marginal adaptation, anatomic form, surface texture, occlusal morphology, and caries were used to evaluate each restoration clinically; marginal adaptation also was evaluated indirectly utilizing clinical photographs. Thirty-six month results are hereby reported (a previous 18-month report has been published).⁹

Methods and Materials

Twenty-six patients (age 5-13 years) selected for this study demonstrated 50 contralateral pairs of permanent and primary molars with incipient occlusal caries and 17 pairs with carious buccal or lingual pits. Following administration of local anesthesia and isolation of the appropriate teeth with a rubber dam, Class I cavities were prepared. Any deep caries was removed with an appropriate size round bur in a low-speed, contra-angle handpiece. Pulp protection in deep cavity preparations was achieved using Dycal^a as a liner, cavity varnish^b to seal the dentin walls, and zinc phosphate cement base^c to provide ideal cavity depth. Regular set Tytin[®] amalgam in 800 mg pre-dispensed capsules^d was triturated with an amalgamator^e for 6 seconds, carried to the preparation, condensed and over-packed with a large face condenser. The amalgam first was burnished with a #

^a Dycal-L.D. Caulk Co.; Milford, DE.

^b Copalite-Cooley & Cooley, Ltd.; Houston, TX.

^c Missy, Inc.; Clifton Forge, VA.

^d S.S. White Dental Products International; Holmdel, NJ.

^e Capmaster-S.S. White Division of Pennwalt Corp.; King of Prussia, PA.

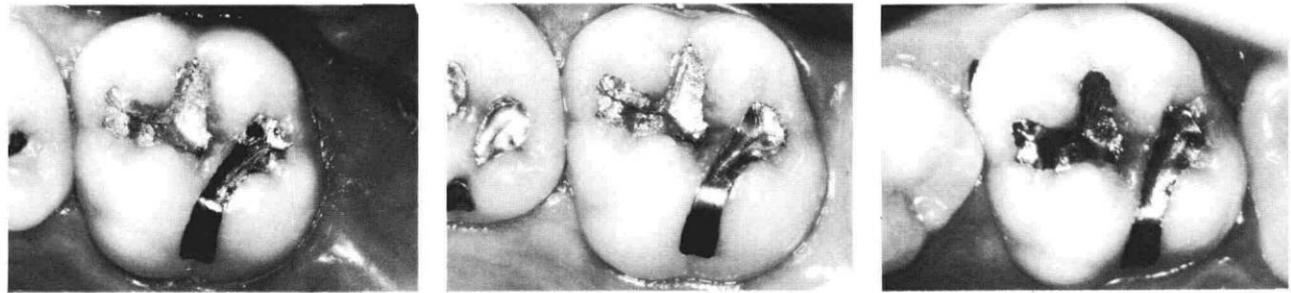


FIGURE 1. Maxillary right first permanent molar with typical amalgam restorations, mesial-occlusal is carved-only and distal-occlusal-lingual is a polished restoration: a (left) baseline; b (center) 12 months; c (right) 36 months.

21B anatomical burnisher and carved with a 7C discoid/cleoid carver, followed by a 5C carver. An explorer was used to refine and remove flash at the margins. All amalgams were packed and carved within 8 minutes from the start of trituration.

The restorations were designated for either carved-only or polished after 24 hours by following a randomized numerical chart for right or left, and then adjusting for the last pair in order to obtain equal numbers of right and left carved-only pairs. A #6 or a #4 pear-shaped bur was utilized to establish cuspal planes and the grooves were refined with a #2 round finishing bur or a #0 flame-shaped bur at low speed. Then a thin slurry of XXX Silex[†]-water and finally a creamy mix of tin oxide[§]-water applied with an unwebbed rubber cup at low speed provided a highly polished surface. The contralateral restoration remained as carved.

The amalgams were evaluated using previously published written criteria for: marginal adaptation, anatomical form, surface texture, occlusal morphology, and caries¹⁰ at baseline and at each subsequent six-month recall appointment.

Additionally, black and white photographs were taken of each tooth at baseline and at 6, 18, and 36 months using a camera with a 200 mm macrolens set at 1.5x. The black and white negatives then were enlarged to 6.4x. The resulting prints were compared to six photographs of representative restorations depicting each of the modified criteria used for the clinical evaluation.¹⁰ The amount of marginal overextension (flash) also was assessed photographically for each restoration.¹⁰

Independent evaluations were made by three faculty members. A consensus was reached when at least two agreed independently on the same rating for each clinical and photographic evaluation. If no consensus occurred, the three examiners reviewed the clinical or photographic scoring in order to reach a consensus agreement.

Each restoration (carved-only or polished) was compared at various time intervals with its own baseline evaluation by the Wilcoxon matched-pair, rank-sum test. The paired restorations (carved-only and polished) also were compared with each other at the same time intervals by the chi-square analysis test. When the expected frequency number was too small, the number in the "less" or "more" column was added to the "no difference" column to perform a chi-square analysis.

Results

Sixty-seven pairs of amalgam restorations were inserted and evaluated at baseline. By 36 months the number available at recall diminished to 40 pairs.

The clinical evaluation of marginal adaptation revealed no significant difference *between* the carved-only and the polished restorations from baseline through 36 months (Tables 1 & 2). The margins of both the carved-only and the polished restorations became significantly more detectable from baseline to 6 months (Table 2). The margins of the polished restorations became significantly more detectable from baseline to 18 months and from baseline to 36 months (Table 2); there was a similar change in the carved-only restorations, but it was not statistically significant at either time period.

The photographic evaluation revealed significantly better marginal adaptation at baseline for the carved-only restorations than for those which were polished (Table 3). The margins of both groups deteriorated significantly from baseline to 6, 18, and 36 months (Table 4). From baseline to 6 months the margins of carved-only restorations showed a significant change, a greater number of margins becoming more detectable than in the polished restorations (Table 4). By 18 and 36 months there was no significant difference in the degree of change in margin detectability from baseline between carved-only and polished restorations (Figures 1a-c).

The polished restorations had significantly smoother surface texture ratings than carved-only restorations

[†] Moyco Industries, Inc.; Philadelphia, PA.

[§] Matheson, Coleman & Bell; Norwood, OH.

TABLE 1. Clinical Consensus Ratings for Marginal Adaptation

Margin ratings*	Baseline		6 Months		18 Months		36 Months	
	Carved-Only	Polished	Carved-Only	Polished	Carved-Only	Polished	Carved-Only	Polished
1. No detection	5	7		1	4	2	3	2
2. Less than 50%	62	60	54	53	37	42	31	31
3. Greater than 50%			1	1	4	2	5	4
4. Crevice less than 50%			2	2	3	3	1	3
5. Crevice greater than 50%								
6. Crevice to the dentin								

* Criteria given in previous publication.¹⁰

TABLE 2. Clinical Comparison of Margin Evaluation Carved-Only or Polished (Pairs)

Restoration Groups	Time (Months)	No Difference	Margins Less Detectable	Margins More Detectable	P-Value	Test
Carved-Only	BL-6 Mos	50	0	7	0.0156	Wilcoxon*
Polished	BL-6 Mos	49	0	8	0.0078	Wilcoxon*
					1.0	X ²
Carved-Only	BL-18 Mos	36	3	9	0.146	Wilcoxon
Polished	BL-18 Mos	38	1	10	0.0117	Wilcoxon*
					0.58	X ²
Carved-Only	BL-36 Mos	32	1	7	0.0703	Wilcoxon
Polished	BL-36 Mos	29	1	10	0.0117	Wilcoxon*
					0.58	X ²

BL = Baseline, X² = Chi-square test, * = Significant difference.

TABLE 3. Photographic Consensus Ratings for Marginal Adaptation

Margin Ratings*	Baseline		6 Months		18 Months		36 Months	
	Carved-Only	Polished	Carved-Only	Polished	Carved-Only	Polished	Carved-Only	Polished
1. No Detection	31	17	5	8	1	3		1
2. Less than 50%	36	49	44	41	26	26	14	15
3. Greater than 50%		1	7	7	17	15	24	22
4. Crevice less than 50%			1	1	1	1	1	1
5. Crevice greater than 50%								
6. Crevice to the dentin								

° Significant differences in restorations between methods within one time period (Wilcoxon matched-pair rank-sum test, p<.05).

* Criteria given in previous publication.¹⁰

TABLE 4. Photographic Comparison of Margin Evaluation Carved-Only or Polished Pairs

Restoration Groups	Time (Months)	No Difference	Margins Less Detectable	Margins More Detectable	P-Value	Test
Carved-only	BL-6 Mos	31	0	26	0.0	Wilcoxon*
Polished	BL-6 Mos	38	3	16	0.0044	Wilcoxon*
					0.04	X ² *
Carved-only	BL-18 Mos	11	0	34	0.00	Wilcoxon*
Polished	BL-18 Mos	19	1	26	0.00	Wilcoxon*
					0.09	X ²
Carved-only	BL-36 Mos	5	0	34	0.00	Wilcoxon*
Polished	BL-36 Mos	7	1	31	0.00	Wilcoxon*
					0.5434	X ²

BL = Baseline; X² = Chi-square test; * = Significant difference.

at baseline and this difference continued through 36 months (Tables 5 & 6, Figure 1). At baseline, the

carved-only restorations appeared granular in texture while the polished restorations exhibited a shiny, reflective surface (Figure 1a). By 36 months, 40% of the carved-only restorations significantly improved in surface texture from 18 months with 16 restorations exhibiting a satin smooth texture (rating of 2, Table 5). From baseline to 6 months the carved-only restoration did not change significantly, but from baseline to 18 and 36 months, the surface texture of a significant number of restorations became *more* shiny smooth. The polished restorations from baseline to 6, 18, and 36 months became significantly *less* shiny smooth (Table 6). There was a significant difference between the two groups from baseline to 6, 18, and 36 months. In all instances, the polished restoration was the smoother of the pair at baseline. However, from baseline to 36 months, 17 carved-only restorations became smoother, 39 polished restorations lost smoothness, and 24 restorations exhibited no difference in surface texture (Table 6).

Photographic analysis of flash revealed no significant difference from baseline through 36 months between carved-only and polished restorations. By 36 months, both groups of restorations had less flash than at baseline.

Three clinical criteria (anatomic form, occlusal morphology, and caries) demonstrated no significant changes either within or between the two groups at any evaluations during the 36 months of the study. There was no evidence of recurrent caries around restorations in either group.

The consensus agreement (two out of three evaluators) for anatomic form, occlusal morphology, caries, clinical marginal adaptation, and surface texture averaged 100% for the 36 months of this study. The consensus agreement for the photographic evaluation of marginal adaptation and flash averaged 99.45% for the 36 months.

Margin adaptation was evaluated using two different methods: clinically, using an explorer and mouth mirror; and photographically, using black and white prints which magnified the restoration 9.6x.

When the two evaluations were compared for the

margins of each carved-only restoration at all of the time intervals, the photographic method showed a significant deterioration of the margin from baseline to 6, 18, and 36 months, while the clinical evaluation noted a significant deterioration only from baseline to 6 months. There was a significant difference between the two evaluation methods, with the photographic method depicting more margin deterioration at all time periods (Table 7).

When the two evaluations were compared for the margins of each polished restoration, both clinical and photographic methods showed significant margin deterioration from baseline to 6, 18, and 36 months. The photographic method depicted significantly more margin deterioration than the clinical method from baseline to 18 and to 36 months (Table 8).

Discussion

The only major change in the evaluation between carved-only and polished amalgam restorations during the 36 months was related to surface texture, where 40% of the carved-only restorations became satin smooth in surface texture. At all time periods evaluated, a significant change in texture occurred between carved-only and polished restoration (Table 6). This self-polishing of the occlusal amalgams must be a result of repeated masticatory function and possibly tooth brushing, and may be specific to a high copper spherical alloy.

There was no difference in margin integrity between carved-only and polished restorations through 36 months. The rating of margin integrity progressively deteriorated from baseline through 36 months for both evaluation procedures (Tables 2 & 4). Only the photographic evaluation of margins rated the carved-only restorations significantly better at baseline, but by 6 months both groups had similar margins (Tables 3 & 4). It is also possible that the minor margin discrepancies that were detected clinically at baseline were not visible on the flat plate of a photograph which could be viewed only at a fixed angle.

Birtcil, et al.¹¹ concluded that marginal integrity was less affected by finishing procedures in the high cop-

TABLE 5. Clinical Consensus Ratings for Surface Texture

Ratings*	Baseline		6 Months		18 Months		36 Months	
	Carved-Only	Polished	Carved-Only	Polished	Carved-Only	Polished	Carved-Only	Polished
1. Shiny		66						
2. Satin smooth		1		57	6	44	16	38
3. Granular	65		56		41	4	24	2
4. Dull	2		1		1	1		

* Significant difference in restorations between methods at one time period (Wilcoxon matched-pair rank-sum test, $p < .05$).

* Criteria given in previous publications.^{9,10}

TABLE 6. Clinical Comparison of Surface Texture Carved-Only or Polished Pairs

Restoration Groups	Time (Months)	No Difference	Less Shiny Smooth	More Shiny Smooth	P-Value	Test
Carved-only	BL-6 Mos	56	0	1	1.00	Wilcoxon
Polished	BL-6 Mos	1	56	0	0.00	Wilcoxon*
					0.0	χ ^{2*}
Carved-only	BL-18 Mos	40	0	8	0.0078	Wilcoxon*
Polished	BL-18 Mos	1	48	0	0.000	Wilcoxon*
					0.0	χ ^{2*}
Carved-only	BL-36 Mos	23	0	17	0.00	Wilcoxon*
Polished	BL-36 Mos	1	39	0	0.00	Wilcoxon*
					0.00	χ ^{2*}

BL = Baseline; χ² = Chi-square test; * = Significant difference.

TABLE 7. Margin Rating Comparison of Clinical and Photographic Evaluation Carved-Only Restorations Pairs

Evaluation Method	Time (Months)	No Difference	Margin Less Detection	Margin More Detection	P-Value	Test
Clinical	BL-6 Mos	50	0	7	0.0156	Wilcoxon*
Photographic	BL-6 Mos	31	0	26	0.0	Wilcoxon*
					0.0002	χ ^{2*}
Clinical	BL-18 Mos	36	3	9	0.146	Wilcoxon
Photographic	BL-18 Mos	11	0	34	0.00	Wilcoxon*
					0.00	χ ^{2*}
Clinical	BL-36 Mos	32	1	7	0.0703	Wilcoxon
Photographic	BL-36 Mos	5	0	34	0.000	Wilcoxon*
					0.00	χ ^{2*}

BL = Baseline, χ² = Chi-square test; * = Significant difference.

TABLE 8. Margin Rating Comparison of Clinical and Photographic Evaluation Polished Restorations Pairs

Evaluation Method	Time (Months)	No Difference	Margins Less Detectable	Margins More Detectable	P-Value	Test
Clinical	BL-6 Mos	49	0	8	0.0078	Wilcoxon*
Photographic	BL-6 Mos	38	3	16	0.0044	Wilcoxon*
					0.1078	χ ²
Clinical	BL-18 Mos	38	1	10	0.0117	Wilcoxon*
Photographic	BL-18 Mos	19	1	26	0.00	Wilcoxon*
					0.0006	χ ^{2*}
Clinical	BL-36 Mos	29	1	10	0.0117	Wilcoxon*
Photographic	BL-36 Mos	7	1	31	0.00	Wilcoxon*
					0.00	χ ^{2*}

BL = Baseline; χ² = Chi-square test; * = Significant difference.

per amalgams. Throughout this study, differences in margin adaptation could not be detected between carved-only and polished restorations except at baseline with the photographic analysis. Therefore, polishing did not result in better margin adaptation, (Tables 1-4). Due to the consistency with which all margins clinically were evaluated detectable, (ratings 2 or 3) but without crevice formation (rating 4), one must question the value of recalling patients for the conventional 24-hour polishing.

Because this study was designed to evaluate margins by a clinical explorer and a photographic analysis, a comparison of the two evaluation methods was performed. At baseline the carved-only restoration was ranked by the photographic analysis to have statistically better margins, but by 36 months there was no difference (Table 3). The photographs depicted significantly more restorations with marginal breakdown at all time intervals (Tables 7 & 8). The photographic evaluation presented potential prob-

lems in obtaining sharp focus, clarity, and defining shadows, and it also eliminated the use of tactile sensation in the discrimination of marginal discrepancies. The increased marginal breakdown evidenced in the photographic evaluations may be due to the static nature of the examination.

From baseline through 18 months, surface texture was significantly rougher for the carved-only restorations but by 36 months, 40% of the carved-only restorations had developed a smoother texture (Table 5). However, even after 36 months, the polished restorations were significantly smoother than the carved-only restorations. It is of interest that a change in texture occurred from baseline through 36 months, thus allowing speculation that the surface of the carved-only restorations will become smoother with time.

It has been shown previously¹² that surface texture can be improved significantly by polishing immediately after insertion (8 minutes). After 36 months, 81% of the restorations polished at 8 minutes had a similar surface texture to those which were polished after 24 hours. From a clinical viewpoint, surface texture may be handled best in this manner.

The presence of flash was evaluated and followed to determine if there was a correlation between margin deterioration and the amount of flash. From this study, flash had little or no effect on margin deterioration from baseline through 36 months.

Rogers¹³ reported in a recent thesis, which surveyed general dentists in Michigan, that 64% polished less than one-half of their amalgam restorations on a routine basis. The majority of the polishing performed was done at the six-month recall. The most frequent reasons given for not polishing amalgam restorations were the feeling that polishing was not necessary to obtain a durable restoration and that polishing procedures consumed too much chairside time for the improvement in clinical performance that was derived. This was substantiated in the present study after 36 months.

Conclusion

When an ideal cavity outline form was obtained and proper isolation, condensation, and carving at the margins was achieved, the following conclusions can be stated.

1. There was no significant difference in the clinical ratings for margin integrity between carved-only and polished amalgam restorations (Tytin) through 36 months. Polishing of Class I amalgam restorations did not result in better adapted margins after 36 months in function.
2. The ratings for margin integrity progressively de-

teriorated from baseline through 36 months for carved-only and polished restorations.

3. Only the photographic analysis rated the margins of the carved-only restorations significantly better at baseline.
4. The photographic analysis of margins from baseline to 6, 18, and 36 months demonstrated a significantly more detectable margin than was found in the clinical evaluation.
5. Surface texture was significantly smoother for the polished restorations at baseline and continued throughout the 36 months; by 36 months there was a statistically significant number of restorations exhibiting improvement in surface texture for the carved-only restorations.

The authors express their appreciation to Drs. Tom Oper, and Dean Sueda for their help in the clinical placement of these restorations as partial fulfillment of the MS degree at the University of Michigan.

Dr. Straffon is a professor, pedodontics; Dr. Corpron is chairman and a professor, pedodontics; Dr. Dennison is a professor, operative dentistry and dental materials; Dr. Carron is an assistant professor, pedodontics; and Dr. Asgar is a professor, dental materials, School of Dentistry, The University of Michigan, Ann Arbor, MI 48109-1078. Reprint requests should be sent to Dr. Straffon.

1. Craig RG: Restorative Dental Materials, 6th ed. St Louis; CV Mosby Co, 1980.
2. Nadal R: Amalgam restorations: cavity preparation, condensing, and finishing. *JADA* 65:66-77, 1962.
3. Charbeneau GT: An appraisal of finishing and polishing procedures for dental amalgam. *J Michigan Dent Assoc* 46:135-38, 1964.
4. Charbeneau GT: Polishing amalgam restorations. *J Michigan Dent Assoc* 47:320-25, 1965.
5. Busquets DJ, Osorno MC, Turner DR: Effects of finishing and polishing of amalgams at specific time intervals. Master's thesis, University of Michigan School of Dentistry, 1978.
6. Dahi F, Dorfman RL, Asgar K, Corpron RE: Microscopic observations of amalgams carved by different methods and subsequently polished. *JADA* 97:197-201, 1978.
7. Oilo G: Adaptation of amalgams to cavity walls. *J Oral Rehabil* 3:227-36, 1976.
8. Tidmarsh BG, Gavin JB: Finishing amalgam restorations — a scanning electron microscope study. *New Zealand Dent J* 69:175-82, 1973.
9. Straffon LH, Corpron RE, Dennison JB, Carron SH, Asgar K: A clinical evaluation of polished and unpolished amalgams: 18-month results. *Pediatr Dent* 5:177-82, 1983.
10. Corpron RE, Straffon LH, Dennison JB, Carron SH, Asgar K: A clinical evaluation of polishing amalgams immediately after insertion: 18-month results. *Pediatr Dent* 4:98-105, 1982.
11. Birtcil RF, Pelzner RB, Stark MM: A 30-month clinical evaluation of the influence of finishing and size of restoration on the margin performance of five amalgam alloys. *J Dent Res* 60:1949-56, 1981.
12. Corpron RE, Straffon LH, Dennison JB, Carron SH, Asgar K: A clinical evaluation of polishing amalgams immediately after insertion: 36-month results. *Pediatr Dent* 5:126-30, 1983.
13. Rogers AM: A survey of the current practices of finishing and polishing of dental amalgam restorations. Master's thesis, University of Michigan School of Dentistry, 1983.