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A clinical evaluation of polishing amalgams immediately after insertion: 36-month results

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

Abstract

Thirty-six patients, 7-13 years of age, demonstrated 96 pairs of contralateral occlusal fissure and buccal and lingual pit cavities which were restored with a high-copper amalgam. One restoration in each pair was polished with a slurry of XXX-Silex in an unwebbed rubber cup at eight minutes following trituration. The contralateral restoration was finished with assorted pear-shaped finishing burs and polished with a slurry of XXX-Silex, followed by a slurry of tin oxide. Each restoration was evaluated clinically by three examiners for five criteria which included modified Ryge clinical evaluation of marginal adaptation. Black and white photographs of each restoration taken at baseline and at six-month intervals for 36 months were evaluated using a modified Mahler method for assessment of marginal adaptation. Areas of marginal flash also were evaluated.

Clinically, marginal adaptation became progressively more detectable for both groups from baseline up to 24 months, but there was no significant difference between the two different polishing methods during the 36 months. At baseline the surface texture of the restorations polished at eight minutes was granular compared to the glossy surface of those polished at 24 hours, but by 36 months the surface texture of both groups was similar.

The often maligned amalgam restoration is still the most commonly used dental restoration, even though claims persist that its longevity is limited.[1,2] The major reasons for the replacement of amalgams include recurrent decay and poor marginal adaptation.[2] While it is possible to control recurrent decay with a comprehensive preventive program, marginal adaptation is linked primarily to the physical properties and the manipulation of the amalgam. Improved marginal adaptation and reduced surface tarnish and marginal corrosion are among the purported benefits of finishing and polishing of amalgam restorations.[3-6] A period of at least 24 hours after insertion generally has been advocated for the finishing and polishing of conventional amalgams. However, it has been postulated that "immediate" polishing is possible for the newer high-copper amalgams because of improved physical properties such as faster setting time and earlier development of high compressive strength.[7-9] The aim of this study is to compare clinically for a three-year period the effects of polishing high-copper amalgam restorations at an interval of eight minutes after trituration with those finished and polished at least 24 hours after placement.

Methods and Materials

Thirty-three patients, age 7-13 years, who were selected for this study exhibited 66 contralateral pairs of Class I occlusal cavities and 30 pairs involving buccal or lingual pits. After administration of local anesthetic and tooth isolation with a rubber dam, the cavities were prepared with a #56 fissure bur utilizing high speed and restored with a high-copper amalgam (regular-set Tytin[a]).[10] The restorations were designated by randomized assignment for either immediate polishing at eight minutes after the start of trituration, or finished and polished at 24 hours after insertion.

The first method of polishing was accomplished during the operative appointment for one restoration of each pair at eight minutes after the start of trituration of the amalgam. A creamy mix of XXX-Silex[b] and water was applied with an unwebbed rubber cup in a slow-speed contra-angle handpiece to the restoration for a period of less than one minute per surface. The rubber cup was moved from the central fossa peripherally over the

[a] S.S. White Dental Products International, Holmdel, N.J.
[b] Moyco Industries, Inc., Philadelphia, Pa.

amalgam-enamel margins until the entire surface appeared clean and well defined. The second method designated that the other contralaterally paired restoration be finished and polished after at least 24 hours by a conventional method utilizing pear-shaped finishing burs, XXX-Silex, and tin oxide.[10]

Two methods were used to evaluate the two techniques of polishing amalgams. The first method was a clinical examination by three examiners based on the modifed Ryge explorer examination.[11-13] The criteria to be evaluated included marginal adaptation, surface texture (Tables 1 and 2), anatomic form, occlusal morphology, and caries.[10] The teeth were examined at baseline and at six-month intervals for a period of three years.

The second method was a modification of that developed by Mahler[14] in which marginal adaptation was assessed from black and white photographs taken of each restoration at baseline, 6, 12, 18, and 36 months, and compared to photographs of six representative restorations depicting specific stages of marginal deterioration.[10] Additionally, the amount of marginal flash was assessed for each restoration: Category 1 — no flash, Category 2 — one or two areas of flash, Category 3 — three or four areas, Category 4 — more than four areas.

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

Results

At the baseline appointment, 96 pairs of amalgam restorations were evaluated independently by three examiners with a mirror and explorer for five criteria, while two criteria were evaluated from photographs of the restorations.[10] At the subsequent six-month recall appointments, the numbers gradually diminished to 60 pairs at 24 months then increased to 73 pairs at 36 months (Table 3), a retention rate of 76% for the study population.

Three criteria evaluated clinically (anatomic form, occlusal morphology, and caries) demonstrated no significant changes at any evaluation during the three years of the study, and no significant differences for these criteria appeared between the restorations polished at eight minutes and 24 hours.

The clinical evaluation of marginal adaptation revealed no significant differences ($p < 0.05$) between the two methods of polishing during the three-year period, however the ratings for marginal adaptation were observed to worsen progressively for restorations polished at both eight minutes and 24 hours with significant differences between prior ratings of both methods observed at 6, 12, 18, and 24 months (Table 3).

Table 1. Criteria for Quality Evaluation

Marginal Adaptation (Dry)	Modified Rating	Health Center Criteria[11]
Restorative material is continuous with adjacent tooth structure — not detectable with a sharp explorer, passes in either direction	1	Alpha
Margin detectable by explorer examination only — along less than 50% of exposed margin	2	Alpha
Margin detectable by explorer examination only — along more than 50% of exposed margin	3	Alpha
Visible evidence of crevice formation into which the explorer will penetrate along less than 50% of exposed margin	4	Bravo
Visible evidence of crevice formation into which the explorer will penetrate along more than 50% of exposed margin	5	Bravo
Crevice formation with exposure of underlying dentin or base	6	Charlie

Table 2. Criteria for Quality Evaluation

Surface Texture	Rating
Glossy	1
Satiny	2
Granular	3
Dull	4
Voids, pits, or scrtaches present — less than 50% exposed area	5
Voids, pits, or scratches present — more than 50% exposed area	6
Evidence of dark discoloration	7

A significant difference in surface texture between the restorations polished at eight minutes and 24 hours was obvious beginning at baseline evaluation and continuing throughout the three years (Table 3). At baseline, the restorations polished at eight minutes appeared uniformly granular with a smooth but dull finish (Figure 1a), while those restorations polished at 24 hours exhibited a shiny, reflective surface (Figure 2a). Although the significant differences in surface texture between the restorations polished at the two different time intervals persisted throughout the study, by three years the differences in appearances in the surface texture between the two groups had narrowed so that many pairs of restorations, especially occlusal restorations, appeared similar (Figures 1d and 2d).

The photographic evaluation of the marginal adapta-

Table 3. Consensus Ratings for Criteria of Quality Evaluation

Clinical Evaluation

Criteria	Baseline		6 Months		12 Months		18 Months	
N (Pairs)	96		91		86		82	
	8 Min	24 Hr	8 Min	24 Hr	8 Min	24 Hr	8 Min	24 Hr
	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.
Marginal Adaptation	1.58 ±.49	1.66 ±.48	1.96[a] ±.47	1.96[a] ±.44	2.00 ±.31	2.03 ±.32	2.12[a] ±.36	2.14[a] ±.44
Surface Texture	3.97[b] ±.31	1.06 ±.43	2.89[a,b] ±.66	2.12[a] ±.74	2.76[a,b] ±.57	1.94[a] ±.44	2.50[a,b] ±.57	2.04 ±.46

Photographic Evaluation

Marginal Adaptation	1.32[a,b] ±.49	1.93 ±.39	2.02[a,b] ±.52	2.47[a] ±.60	2.44[a,b] ±.73	2.70[a] ±.55	2.56[b] ±.69	2.71 ±.53
Flash	2.02[a,b] ±.75	1.70 ±.54	1.84[a] ±.65	1.77 ±.60	1.86 ±.65	1.82 ±.56	1.80 ±.66	1.79 ±.51

[a] Significant difference ($p < 0.05$) in restorations polished by the same method for two consecutive six-month periods.
[b] Significant difference ($p < 0.05$) in restorations polished by the two methods at one time period.
Statistical Test: Michigan Interactive Data Analysis System (MIDAS: Paired t-test)

Clinical Evaluation

Criteria	24 Months		30 Months		36 Months	
N (Pairs)	61		71		74	
	8 Min	24 Hr	8 Min	24 Hr	8 Min	24 Hr
	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.	$\overline{X}\pm$S.D.
Marginal Adaptation	2.42[c] ±.56	2.38[c] ±.52	2.33 ±.58	2.34 ±.61	2.40 ±.57	2.40 ±.55
Surface Texture	2.47[d] ±.83	2.23 ±1.12	2.34[c,d] ±.66	2.14 ±.72	2.29[d] ±.79	2.05 ±.64

Photographic Evaluation

Marginal Adaptation	N.A.	N.A.	N.A.	N.A.	2.55 ±.69	2.56[c] ±.76
Flash	N.A.	N.A.	N.A.	N.A.	1.23[c] ±.42	1.23[c] ±.46

[c] Significant difference ($p < 0.05$) in restorations polished by the same method for two different time periods.
[d] Significant difference ($p < 0.05$) in restorations polished by the two methods at the same time period.

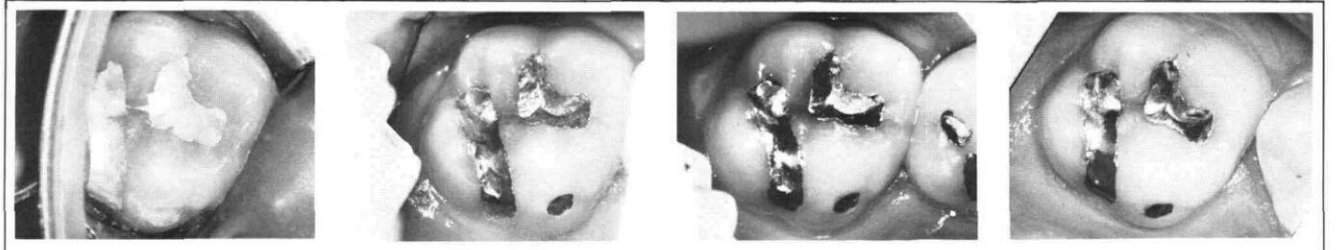

Figure 1 a-d. Restorations polished at eight minutes (Patient #03, Tooth 14^{5}, 14^{4-6}): (a) baseline; (b) 6 months; (c) 18 months; and (d) 36 months.

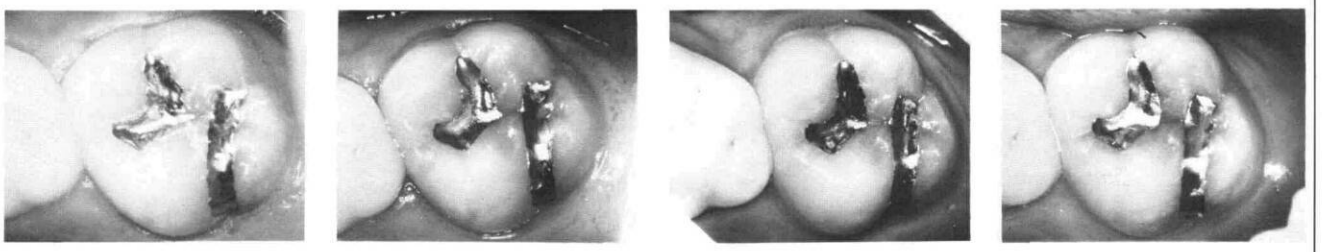

Figure 2 a-d. Restorations polished after 24 hours (Patient #03, Tooth $\#3^{5}$, 3^{4-6}): (a) baseline; (b) 6 months; (c) 18 months; and (d) 36 months.

tion clearly revealed that the margins of restorations polished at both eight minutes and 24 hours gradually worsened with significant differences between the two methods up to 18 months (Table 3), but the difference had disappeared by 36 months. Additionally, only at baseline evaluation was the amount of flash observed for restorations polished at 24 hours significantly less than those restorations polished at eight minutes. A significant difference in the amount of flash observed for restorations polished at eight minutes appeared only during the first six months of the study, with no subsequent changes of either method for subsequent intervals of evaluation (Table 3).

No recurrent caries involving the restorations polished by either method were observed during the three-year period. The first marginal crevice formation appeared at 24 months in an occlusal restoration of a mandibular permanent first molar. By three years the restorations which exhibited crevice formation were distributed equally with two for each method of polishing.

Our consensus agreement for the clinical evaluations of anatomic form, occlusal morphology, and caries averaged 99% throughout the three years of the study, 97% agreement for surface texture, and in the case of marginal adaptation the agreement was 96% when the ratings were compared to the Dental Health Center scale[10,12] (Table 1). Additionally, the consensus agreement among examiners from the photographic evaluations of marginal adaptation and flash exhibited a range of 94-98% and 93-97%, respectively, over the three years of the study.

Discussion

The dental literature related to dental amalgam generally has supported the need to polish amalgam restorations;[3-6] however, it has been speculated that many practicing dentists routinely do not polish amalgam restorations.[8] The majority of amalgam restorations appear to remain unpolished due to the widely held concept that finishing and polishing procedures should be delayed at least 24 hours after insertion of the restorations,[3-6] which would result in at least one extra appointment to polish one or more amalgam restorations. With the introduction of high-copper amalgams with improved physical properties (i.e., low static and dynamic creep, high early compressive and tensile strength, faster rate of set, and eliminated gamma-2 phase) and improved clinical performance as compared to conventional lathe-cut alloys,[11-23] the need for conventional finishing and polishing procedures has been challenged.[8,9,21] Nitkin and Goldberg[8] observed that even though the high-copper amalgams exhibited improved clinical performance due to the reduction or elimination of the weak, corrosion-prone gamma-2 phase, the polishing procedure still was necessary to remove marginal excesses. They speculated that the degree of set and the early strength of conventional amalgams were inadequate to allow early polishing while restorations of high-copper alloys could be polished at the time of insertion without physical damage to the resulting restorations. Birtcil, et al.[21] concluded that the performance of the margins of high-copper amalgams were less affected by finishing procedures than lathe-cut alloys, and they further speculated that high-copper alloys may not have to be finished in order to perform well clinically.

The immediate polishing procedure represents an alternative method between the carved-only restorations as suggested by Birtcil, et al.[21] and the conventional finishing and polishing methods delayed at least 24 hours after insertion. The immediate polishing procedure retains the advantage of removal of the marginal excesses and still provides a smoother surface than with the carved-only restorations. In the case of the amalgam (Tytin) used in this study, the eight-minute interval from trituration to polishing corresponded roughly to the end of the carving time,[24] and likewise represented a practical period for polishing without unduly prolonging the appointment. The

results of our clinical evaluations revealed that the marginal adaptation of the restorations polished eight minutes after trituration were at least equal to those polished by the conventional methods of finishing and polishing after at least 24 hours (Table 3). These results support the contention by Nitkin and Goldberg[8,9] that the fast-setting, high-copper amalgams can be polished at the time of insertion. Additionally, our photographic evaluation revealed that the restorations polished at eight minutes exhibited more flash than those polished at 24 hours at the baseline evaluation (Figures 1a and 2a) but subsequently did not affect marginal adaptation adversely (Figures 1d and 2d). In fact, the photographic evaluations of marginal adaptation rated the eight-minute polishing superior to the delayed polishing through the 18-month recall (Table 3).

The effect of immediate polishing upon the surface of the restoration was of major concern during this study. Prior testing of the effect of various polishing abrasive agents on the surface of the amalgam,[25] revealed that the use of XXX-Silex represented a simple, quick method that yielded a relatively smooth surface when a creamy slurry was applied with very light pressure. The procedure was limited to less than one minute of application per restoration in order to avoid heat generation and subsequent damage to a newly condensed surface. Our observations of restorations polished at eight minutes revealed a granular texture of the surface of the restoration (Figure 1a), but during the study there appeared definite improvement in the surface texture such that by three years, many of the restorations polished at eight minutes approached the surface texture of its paired restoration polished at 24 hours (Table 3). Although the "self-polishing" of the occlusal amalgams appeared to result from repeated masticatory function, it remains to be seen if the proximal portions of multisurface amalgam restorations will experience similar improvement in surface texture.

Conclusions

The early polishing method for a high-copper amalgam (Tytin) used to restore pit and fissure caries produced restorations with marginal adaptation comparable to those which were polished conventionally after a period of at least 24 hours following insertion. Additionally, though the surface texture of the restorations was initially granular when polished at the time of insertion, by 36 months many appeared similar to the paired restorations polished after 24 hours.

Further study of the early polishing method should be performed to verify its efficacy for use with multisurface restorations of high-copper amalgam.

Dr. Corpron is chairman and professor of pedodontics; Dr. Straffon is professor of pedodontics; Dr. Dennison is professor of operative dentistry; Dr. Carron is assistant professor of pedodontics; and Dr. Asgar is professor of dental materials, all at the School of Dentistry, The University of Michigan, Ann Arbor, Mich. 48109. Requests for reprints should be sent to Dr. Corpron.

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