Physical properties vs. clinical performance of pure gold restorations

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In order to predict the clinical performance of dental restorations, valid relationships should be established between physical properties as tested in the laboratory and performance under clinical conditions. In this study, such relationships were investigated for pure gold restorations. Furthermore, with the advent and extended use of powdered gold in the field of cohesive gold restorations, it was considered desirable to evaluate this form of pure gold for clinical behavior.

The physical properties of four forms of pure gold using two different condensation procedures were reported in a previous publication.[1] The results of this study are summarized in Table I. Since transverse strength may be considered to be a measure of the cohesiveness of the gold specimen and Knoop hardness may be considered to be a measure of the compaction of the gold specimen, these two properties were selected as possible predictors of clinical performance.

In brief, these laboratory results demonstrated that gold foil had both the highest transverse strength and the highest hardness number of all materials tested with the exception that mat gold with a veneer of gold foil had a hardness equal to that of gold foil alone. All other materials showed no difference in these two physical properties. The question posed was whether clinical performance would reflect the physical property differences or similarities demonstrated by these laboratory tests.

MATERIALS AND METHODS

The materials shown in Table I were used in the clinical placement of Class V gingival restorations with the exception that the foil veneer was used over the pow-

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Table I. Physical properties of pure gold restorations

Properties	*Material*			
	Gold foil	*Mat gold plus foil*	*Powdered gold*	*Mat gold*
Hand condensed				
Transverse strength (p.s.i.)	42,300	28,000	23,600	23,000
Knoop hardness	69	70	55	52
Mechanically condensed				
Transverse strength (p.s.i.)	37,900	29,400	22,200	24,100
Knoop hardness	70	71	64	62

dered gold rather than the mat gold. Thus, the four materials placed were gold foil,* powdered gold plus a veneer of gold foil, powdered gold† and mat gold.‡ Two different condensation methods were also utilized: hand condensation§ using heavy force (7 pounds) and high-frequency mechanical malleting.‖ Although these two methods of condensation showed no difference in properties for laboratory condensed specimens,[1] there was some question as to whether the heavy forces needed for hand condensation could be applied effectively under clinical conditions. A total of 64 restorations were placed using standardized techniques (eight restorations per condensation condition and per material), and the selection of a material and condensation condition for a given cavity preparation was made using a random number table. Because of recall difficulties, the total number of restorations available for the final analysis was 53.

Following placement of the clinical restorations, a silicone rubber–base impression was made of the surface of each polished restoration, and a silver-plated die was made from the impression. At subsequent yearly recalls, additional silver-plated dies were made of the restorations. The dies were photographed under oblique illumination, and comparisons were made of the photographs of the original die and subsequent yearly photographs to determine if surface and/or marginal discrepancies had occurred. The photographs were ranked from 1 to 53 in accordance with judgments of the quality of the restorations. Criteria used were the extent of surface and marginal defects or discrepancies. Four evaluators were employed, and an average rank was established based on the individual opinions of all evaluators. Fig. 1 shows the

*Morgan, Hastings & Company, Philadelphia, Pa.

†Goldent, Morgan, Hastings & Company, Philadelphia, Pa.

‡Williams Gold Refining Company, Inc., Buffalo, N. Y.

§Loma Linda No. 20 Condenser, Suter Dental Mfg. Company, Chico, Calif.

‖Electromallet, No. 6 condensing point, McShirley Dental Products, Glendale, Calif.

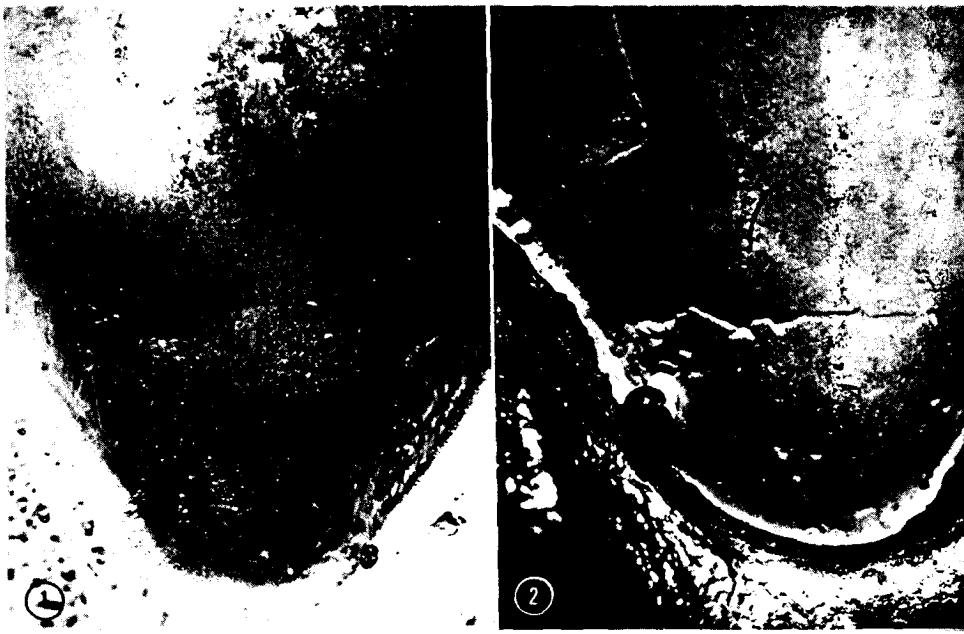

Fig. 1. Restoration ranked No. 1 after five years of clinical service.
Fig. 2. Restoration ranked No. 53 after five years of clinical service.

five-year photograph of the restoration ranked No. 1, and Fig. 2 is the five-year photograph of the restoration ranked No. 53. These figures illustrate the range of surface defects over which clinical efficacy was determined.

RESULTS AND DISCUSSION

The first observation made from the data was that discrepancies in surface and margin which did occur were observed at the one-year recall period but did not change significantly with time. The study was carried through a five-year period, yet most observed changes occurred within the first year of service. This observation suggests that the discrepancies which did occur were probably due to variations in insertion and finishing technique and that weaknesses in cohesion of some surface increments produced localized failure within a short period of time.

The data were analyzed using the H statistic of the rank-sum test to determine whether material type or hand vs. mechanical technique had any influence on the discrepancies observed. The mean ranks for each category are shown in Fig. 3. A lower mean rank signifies a lesser number of surface and/or marginal defects. Although mechanically condensed gold foil appears to demonstrate the least defects, and mechanically condensed mat gold appears to demonstrate the most defects, the subsequent statistical analysis shown in Table II failed to detect any differences among any of the conditions tested.

After a statistical analysis is performed, one is still confronted with the decision as to what order of difference is clinically significant. All of the 53 restorations after five years of service were considered acceptable by clinical standards. Therefore,

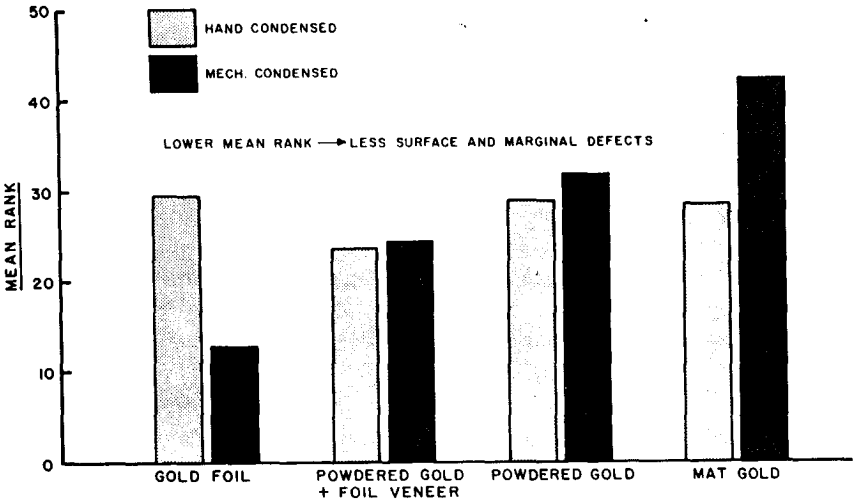

Fig. 3. Extent of surface and marginal defects of pure gold restorations expressed as mean ranks.

Table II. Analysis of the clinical behavior of pure gold restorations (rank-sum test)

	Material			
Method	*Gold foil*	*Powdered gold plus gold foil veneer*	*Powdered gold*	*Mat gold*
Hand condensed	4	6	1	16
	12	11	7	24
	17	14	25	27
	21	23	41	33
	31	28	49	42
	46	30	50	
	51	34		
	53	43		
Mechanically condensed	3	2	19	35
	5	13	22	38
	8	18	26	39
	9	29	36	44
	10	37	40	45
	15	47	48	52
	20			
	32			

$H = 14.06$; $\chi^2_{(7)(.95)} = 14.07$.

even if differences could have been detected, this finding might not be considered of great significance.

These results suggest that the selection of any combination of the four materials and the two condensation conditions would produce an acceptable restoration and that the differences detected in the physical properties of transverse strength and microhardness between materials in a previous study[1] are not reflected in any sig-

nificant differences in clinical performance. Since the restorations in this study were placed under conditions of cavity preparation and material procedure which were carefully standardized, significant failures which do occur in pure gold restorations in clinical practice are most likely a result of less than optimum operative technique.

SUMMARY AND CONCLUSIONS

In this study, pure gold restorations were evaluated for their clinical behavior to determine whether previously established differences in the physical properties of transverse strength and microhardness would be manifest as differences in clinical performance. Four types of pure gold materials and two condensation techniques were investigated. No relationship could be established between the physical property differences found by laboratory test and clinical performance. Furthermore, evaluations of the surfaces of these restorations for periods of up to five years failed to reveal any significant differences among the materials studied or between the insertion techniques used.

Reference

1. Richter, W. A., and Cantwell, K. R.: A Study of Cohesive Gold, J. Prosthet. Dent. 15: 722-731, 1965.

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