Clinical Studies of Dental Cements: III. Seven Zinc Oxide-Eugenol Cements Used for Temporarily Cementing Completed Restorations

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Seven zinc oxide-eugenol cements with compressive strengths from 200 psi to 8,000 psi were used for temporarily cementing completed inlays, crowns, and bridges. The effectiveness of each cement in a variety of clinical situations is presented. Cement of 1,000 psi met the requirements of typical clinical cases most frequently. The cements of compressive strength 200, 400, 600, 2,200, and 3,500 psi were required in other clinical cases with sufficient frequency to justify their use.

The cementation of dental restorations with zinc phosphate cement is often accompanied by pain. It may be followed by hypersensitivity of the teeth and possible pulp death, which is caused by the irritant nature of the cement. These adverse effects of zinc phosphate cement are more decided in the extensive preparation that involves the cutting of many dentinal tubules than in the simple restoration. The effects are more noticeable in the teeth of young patients and in teeth free from previous caries or restorations. The increasing number of fixed prostheses made in the last decade or so has indicated the nature of this clinical problem. Temporary cementation with a sedative zinc oxide-eugenol mixture has become widely practiced to allow a period of time for reduction of the inflammation of the pulp before final cementation with zinc phosphate. This procedure has been described by Ewing,[1] Kazis and Kazis,[2] McCracken,[3] and Baraban.[4]

Two clinical problems are recognized in temporary cementation of restorations. First, the cement should hold the bridge securely in place for the required period and seal all the retainers; second, the cement should not be so strong that the bridge cannot be removed easily when required.

The retentive quality of restorations varies considerably in relation to the type of retainer, the length of the clinical crown, the degree of taper of the preparation, and the length of the bridge.[5-7] The clinician has to rely on trial and error methods of selecting a cement suitable for each restoration. No correlation between the physical properties of a cement for temporary cementation and the requirement of various restorations has been published.

This study was designed to provide a survey of the effectiveness of zinc oxide-eugenol cements of different compressive strengths when used for temporary cementation of a variety of restorations.

Materials and Methods

The seven experimental cements are listed in Table 1, which shows their code letter, compressive strength, and the proportions used. These cements were assigned for the temporary cementation of inlays, crowns, and bridges in the clinic of the School of Dentistry. In some instances temporary cementation was required by the treatment plan; in other instances the restoration was temporarily cemented for a varying period of time to test the cement. This latter procedure was followed to increase the size of the sample. Only patients who were willing to participate and would be available for the necessary visits were included in the study.

The selection of a cement for each restoration in this study presented some

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TABLE 1
CEMENTS SELECTED FOR CLINICAL STUDIES

	Paste Proportions		Powder-Liquid Proportions	
Code and psi	Base Inches	Catalyst Inches	Powder gm	Liquid ml
B-200	1	1	...	...
G-400	1	1	...	...
G-600	1½	1	...	...
A-1,000	1	1	...	...
C-2,200	...	...	0.6	0.3
E-3,500	...	...	0.6	0.3
D-5,400	...	...	0.6	0.3
F-8,000	...	...	0.9	0.37

special problems. The random assignment followed in earlier studies[8,9] was not practical, because inevitably the strongest cement would be assigned to the most retentive restoration at some time. The result, predicted from general clinical experience, would be that the bridge could not be removed easily when required. The experiment could be regarded as unnecessary and the result clinically inconvenient. Some judgment had to be made regarding the needs of each case and the most suitable cement had to be selected to meet the criteria already described. The nature of this study was therefore to follow this procedure under more controlled conditions and with cements of known compressive strength. Success or failure in each restoration was really an evaluation of the ability of the operator to select the correct cement. As the study progressed, the investigator's ability to select the correct cement improved.

The accumulated data, although not suitable for statistical analysis, revealed some helpful information on the selection of cements and on the range of compressive strength that is required to meet the various clinical situations.

In selecting a cement for each restoration, the factors taken into consideration in determining the strength of cement to be used were the type, location and number of retainers, the retentive qualities of retainers, the length of and number of spans of the bridge, the amount of occlusal stress anticipated, and the time the temporary cementation was expected to remain in place.

Care was exercised to select a cement that would allow easy removal of the restoration when required. Selection of too weak a cement, however, would invite loosening of the restoration. The investigators attempted to select the strongest cement for each restoration, which, in the light of previous experience with similar situations, could be removed easily.

In the few restorations in which the two strongest cements (D, 5,400 and F, 8,000) were used, no difficulty in removal was experienced. It might be thought that the highest incidence of difficulty would be found here, but these cements were only used in restorations that had poor retentive quality, some of which were to be modified and remade.

The information collected and recorded when the restoration was cemented included the identification of the patient and the operator, the type of restoration placed, the cement assigned, the date of cementation, and the ease or difficulty of seating the restoration.

Of the 21 restorations that were maintained under temporary cementation, 4 were single restorations, and the remainder ranged from 3 to 12 unit bridges. These restorations were under periodic observation for periods from 3 to 20 months.

On return, each restoration was examined for loose retainers. Excess saliva was removed from the region with an air syringe, and each retainer in turn was subjected to alternate pressure and traction in the general direction of the long axis of the tooth. Traction was applied to the retainer with a burnisher or a scaler with a force of approximately 8 lbs. Pressure was applied by the patient biting firmly on a one-fourth-inch diameter orangewood stick. A loose retainer was readily detected by the movement of residual saliva across the gold-tooth interface. The patient was questioned regarding comfort, sensitivity of the teeth, any unusual taste, and any other symptoms.

When a bridge was removed for recementation, note was made of the ease or difficulty experienced. The bridges were removed with a spring-loaded bridge remover. The criteria used in recording the facility of removal were: easy removal, if the bridge could be removed with light taps from the mallet; and difficult removal, if repeated heavy blows with the mallet were required. After removal of the bridge the cavosurface areas of the retainers were individually examined for any discoloration suggestive of marginal leakage.

Note was made of the facility of cleansing the cement from the abutment. When the cement could be removed by wiping with a cotton pledget or with gentle instrumentation, an easy removal was recorded. If cement stubbornly adhered to the dentin and required vigorous instrumentation, a difficult removal would have been recorded. Note was also made of any difficulty experienced in cleansing the retainers before recementation.

In the 223 cementations, 614 units of inlay and crown or bridge work or both on 374 retainers were represented.

Results

Two hundred and two inlays, bridges, or crowns were removed or failed, and 21 remained in place. These latter restorations were removed and finally cemented only when failure of the temporary cementation was suspected, and removal of the restoration was thought advisable by the examiner. The data regarding these restorations appear in Tables 2-6.

The number of times each of the cements was used can be seen in Table 2 (total cementations).

Table 3 shows a further analysis of the data with successes and failures of various types of restorations that were temporarily cemented. No time period is shown for the successes, since the restoration remained in place for the required time. The time interval between cementation and failure, when it occurred, is shown in the last column.

When too weak a cement was selected, the cement lute was broken. Table 3 shows the incidence of failure with each cement. The incidence of failure varied from 0% to 36%. Many of the failures were successfully recemented with the next stronger cement.

Table 4 shows a further analysis of the data on the failures. The table indicates, if the restoration dislodged into the mouth, how many retainers loosened and whether the patient or the examiner discovered the failure.

Table 5 shows data collected when the restorations were removed. With cement C-2,200, nine of the 26 removals presented difficulties. However, of these nine, cement was used three times without guidance from an investigator.

Few of the cements presented significant difficulties in cleaning the cement either from the dentin or the restoration (Table 5). Where difficulty in cleaning the dentin was experienced, the dentin had been excessively dried before cementation.

Table 6 gives details of restorations still temporarily cemented. The time each restoration has been in place is indicated in the column at the far right. The restorations

TABLE 2
TEMPORARY CEMENTATIONS OF FINISHED RESTORATIONS*

Cement	Singles	Restorations Cemented: Bridges	Splints	Total Cementations
B-200	7	25	2	34
G-400	15	18	2	35
G-600	12	9	0	21
A-1,000	20	38	3	61
C-2,200	12	17	2	31
E-3,500	2	9	0	11
D-5,400	1	1	0	2
F-8,000	0	7	0	7
Total	69	124	9	202

* All restorations are cemented.

TABLE 3

COMPLETED TEMPORARY CEMENTATIONS OF FINISHED RESTORATIONS, ANALYSIS OF SUCCESSES AND FAILURES

Cement	Successes (1 day to 18 months)		Failures		Time of Failure	
	No. of Restorations	Type of Restoration	No. of Restorations	Type of Restoration	Days	Months
B-200	6	Single tooth restoration	1	Single tooth restoration	1	...
	2	2-unit bridge				
	8	3-unit bridge	2	3-unit bridge	1	...
			2	4-unit bridge	1	...
	4	5-unit bridge	1	4-unit bridge		3½
	1	6-unit bridge	1	7-unit bridge		3
	3	8-unit bridge	1	10-unit bridge		4
	1	11-unit bridge	1	13-unit bridge	4	...
Totals	25 successes		9 failures	26%		
G-400	14	Single tooth restoration	1	Single tooth restoration	21	...
	2	2-unit bridge				
	4	3-unit bridge	2	3-unit bridge	1, 4	...
	4	4-unit bridge	2	4-unit bridge	1, 7	...
	4	5-unit bridge	1	5-unit bridge	10	...
			1	13-unit bridge	4	...
Totals	28 successes		7 failures	20%		
G-600	10	Single tooth restoration	2	Single tooth restoration	2, 3	...
	4	3-unit bridge				
	2	4-unit bridge	1	4-unit bridge	90	...
	1	5-unit bridge	1	11-unit bridge		11
Totals	17 successes		4 failures	19%		
A-1,000	17	Single tooth restoration	2	Single tooth restoration	54, 55	...
	2	2-unit splint	1	single	1	...
			1	2-unit bridge	1	...
	19	3-unit bridge	7	3-unit bridge	1-95	...
	5	4-unit bridge	1	4-unit bridge	10	...
	2	5-unit bridge	1	5-unit bridge	24	...
	1	6-unit bridge				
	1	11-unit bridge	1	13-unit bridge	11	...
Totals	47 successes		14 failures	23%		
C-2,200	12	Single tooth restoration	...	...	...	...
	2	2-unit bridge	3	3-unit bridge	2, 12, 14	...
	8	3-unit bridge	2	4-unit bridge	35, 59	...
	4	5-unit bridge	...	...	...	...
Totals	26 successes		5 failures	16%		
E-3,500	2	Single tooth restoration	...	...	...	...
	2	3-unit bridge	3	3-unit bridge	7, 10, 72	...
	2	4-unit bridge	1	4-unit bridge	...	4
	1	5-unit bridge				
Totals	7 successes		4 failures	36%		
D-5,400	1	Single tooth restoration	No failures		...	...
	1	6-unit bridge	No failures		...	...
Totals	2 successes		No failures	0%		
F-8,000	1	2-unit bridge (semirigid)	1	2-unit semirigid	64	...
	2	3-unit bridge	1	3-unit bridge	35	...
	2	4-unit bridge				
Totals	5 successes		2 failures	28%		

TABLE 4
Completed Temporary Cementations of Finished Restorations, Analysis of Failures

Cement	No. of Failures	Restoration Fell Out Into Patient's Mouth	One Retainer Loose, Patient Discovered	One Retainer Loose, Examiner Discovered	More than One Retainer Loose, Patient Discovered	More than One Retainer Loose, Examiner Discovered
B-200	9	4	1	3	1	...
G-400	7	4	...	1	1	1
G-600	4	2	...	2	...	...
A-1,000	14	7	1	4	2	...
C-2,200	5	2	...	2	...	...
E-3,500	4	3	...	...	1	...
D-5,400	0	...	...	...	...	...
F-8,000	2	1	...	...	...	1

TABLE 5
Completed Temporary Cementations of Finished Restorations, Data at Removal of Successes

Cement Code	No. of Successes	Removal		Clean Dentin		Clean Restoration	
		Easy	Difficult	Easy	Difficult	Easy	Difficult
B-200	25	25	0	25	0	25	0
G-400	28	28	0	28	0	28	0
G-600	17	17	0	17	0	17	0
A-1,000	47	45	2	45	2	47	0
C-2,200	26	17	9*	19	7	26	0
E-3,500	7	4	3†	5	2	6	1
D-5,400	2	2	0	2	0	2	0
F-8,000	5	5	0	5	0	5	0

* Used in three instances without assignment; one of these successfully recemented with A-1,000 and two of them successfully recemented with G-400. All three restorations were removed and were cleansed with ease.

† Used in one instance without assignment.

TABLE 6
Temporary Cementations of Finished Restorations Still in Place

Cement	No. of Restorations	No. of Units per Restoration	No. of Retainers per Restoration	Months Each Restoration in Place
B-200	1	10	7	3
G-400	1	3	2	8
	1	4	3	12
A-1,000	1	1	1	8
	1	3	2	8
	2	4	4	12, 12
	1	12	7	18
C-2,200	3	1	3	8, 8, 6
	3	3	6	11, 11, 20
	1	5	3	12
	1	4	2	8
E-3,500	1	1	1	8
	1	3	2	8
	1	4	3	12
F-8,000	2	1	2	10, 10

that have been maintained under temporary cementation are checked at regular intervals and no leakage or caries have been detected. The restorations have remained free from symptoms.

Discussion

The cement most frequently selected was the A-1,000 material that was used in 61 out of the 202 restorations. The next most frequently used materials were the B-200, G-400, and C-2,200, which were used 34, 35 and 31 times, respectively.

The percentage of failures, where the restoration came loose, is indicative of the investigator's ability to assess the retentive qualities of the restoration. Table 3 shows that the incidence of failure with the four most frequently used cements was in the region of 20%. There is always a tendency to pick a cement that may be too weak, and to avoid at all costs picking a cement that may be so strong that one or more retainers need to be cut loose. This procedure was never required for any of the restorations in the study.

Of those restorations which failed, the majority became completely detached from the abutments and fell into the mouth.

Of the 14 restorations where one retainer of a bridge came loose, only two were detected by the patient. Herein lies one of the dangers of temporary cementation procedures, which must always be associated with frequent recall and examination. When more than one retainer came loose without dislodgment in the mouth, the patients detected the problem in five out of seven instances; presumably the greater mobility of a bridge with more than one retainer loose is more readily detected.

A variety of restorations (Table 6) have been retained in position with each of the cements to evaluate the long-term effects. No symptoms have arisen in these instances and there are no clinical indications of marginal leakage. A number of these patients have been followed over a period of 12 months or more.

The cements used in this study were experimental. Since the completion of the study two of the cements, B-200 and C-2,200, have been marketed by the manufacturers. These are available as Caulk 200 and Caulk 2,200 cements.* Kerr Temp-Bond† has a compressive strength of approximately 1,000 psi and has a modifier that can be used to reduce the compressive strength to any point in the range 1,000 to 100 psi.[10] S. S. White ZOE cement‡ has a compressive strength of approximately 3,000 psi. A suitable range of cements is therefore available to the profession.[10]

Conclusions

Cement A-1,000 most frequently met the requirements of the restorations in this study. Cements B-200, G-400, G-600, C-2,200, and E-3,500 were selected with sufficient frequency to indicate the need for cements over this range of compressive strengths to be available, if all clinical needs are to be met. Cements D-5,400 and F-8,000 should not be regarded as required for the temporary cementation of normal clinical restorations. The selection of a cement for the temporary cementation of a restoration can be made on an evaluation of the retentive quality of the restoration and the occlusal stresses to which it will be subjected. The clinician is required to develop his own judgment in this regard. None of the cements presented difficulties in handling or in removal from the dentin, unless excessive drying of the abutment teeth was done before cementation. None of the cements presented difficulties in removal from the restoration when required.

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