Clinical Study of Dental Cements. VI. A Study of Zinc Phosphate, EBA-Reinforced Zinc Oxide Eugenol and Polyacrylic Acid Cements as Luting Agents in Fixed Prostheses

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Three cements were used to cement single restorations and bridges. Patients were recalled and evaluated for satisfactory retention of the restorations. Results obtained for a zinc phosphate cement, a reinforced zinc oxide eugenol cement and a polyacrylic acid cement are presented.

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A previous report[1] gave data on the clinical use as a luting agent of a zinc prosphate and a methyl methacrylate reinforced zinc oxide eugenol cement. This study compares, during a three-year period, a zinc phosphate cement,* a zinc oxide and eugenol cement reinforced with ethoxybenzoic acid and alumina† and a polyacrylic acid cement‡ as luting agents for bridges and single crown restorations.

Materials and Methods

Tenacin was selected because it is the zinc phosphate routinely used in the School of Dentistry. Representative cements of the polyacrylic acid and EBA reinforced zinc oxide and eugenol types were selected and tested for film thickness, consistency, compressive strength, and working time. One cement of each type was selected for optimal qualities in the categories tested.

Patients for the study were selected in the Undergraduate Clinic of the School of Dentistry, The University of Michigan. The criteria applied were, first availability of the patient for periodic recalls over the course of the study and second, willingness to participate in the study. Patient selection on these criteria gave a sample of the greatest variety of restorative problems and as close as possible to those met in the general practice of dentistry.

To achieve an approximately equal distribution of each of the cements, they were assigned on a rotation basis as the cases were completed and ready for cementation. Occasionally the rotation sequence was changed to select a cement more suitable for a particular case. This alteration was always in response to dentin pulp considerations and was never based on retentive factors or operator preference. A routine cementation procedure was used for the cementation of all cases as follows:

1. The cement was assigned.
2. The abutment teeth were isolated with cotton rolls and a saliva ejector and dried with a stream of warm air.
3. If zinc phosphate cement was to be used, two thin coats of varnish§ were applied to the abutments. If Zebacem or P.C.A. was used, the abutments were left unvarnished.
4. To eliminate variables in cement manipulation, one of the two principal investigators mixed the cement according to the manufacturer's directions and applied it to the bridge retainers.
5. If a retainer with pins was involved, cement was placed in the pinholes in the abutment tooth using a Lentulo spiral.
6. The prosthesis was passed to the dental student treating the case to carry out the remainder of the cementation under close supervision of the investigator.
7. The prosthesis was seated with biting force applied through an orangewood stick placed on the occlusal surface of the restoration.

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§ Copalite. H. Bosworth Company, Chicago, Il.

TABLE 1

DISTRIBUTION OF THE CEMENTS

Cement	Single Restorations	Bridges	Total
Zinc Oxide Eugenol	57	195	252
Polyacrylic Acid	47	193	240
Zinc Phosphate	58	159	217
Total	162	547	709

8. While the patient maintained a constant pressure with the orangewood stick the operator completed the marginal adaptation of the restorations.
9. A cotton roll was placed on the occlusal surface of the restoration and the patient was instructed to maintain pressure on the restoration until the elapse of ten minutes from the start of the mix.
10. The excess cement was cleaned from the gingival crevice and the patient dismissed.

Patients were recalled at six-month intervals for the duration of the study. They were instructed to return immediately if any unusual signs or symptoms developed.

At the recall appointment, the bridge was inspected clinically for looseness, recurrent marginal decay, and occlusal harmony. To inspect the restorations for looseness, the quadrant of the mouth where the bridge was located was isolated with cotton rolls and saliva ejector and dried with warm air. A "B"* scaler was placed interproximally under a connector and an occlusally directed force was applied to the bridge. The operator checked visually for movement and the patient was questioned as to whether any movement or unpleasant sensation was detectable. With the area still isolated, the patient put biting pressure on the bridge with an orangewood stick placed on its occlusal surface. If any leakage was noted (fluid escaping from the gold tooth interface), the retainer was recorded as loose. If no fluid movement was detected, then the retainer was recorded as sealed.

Crowns were tested in the same manner except that the B scaler was placed in the interproximal concavity of the crown and engaged in the gold to place an occlusally directed force on the restoration.

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Results

Four hundred and forty one patients participated in the study. Seven hundred and nine cementations of single restorations and bridges were completed.

The distribution of the three cements among the 441 patients was 121 cementations with the zinc oxide and eugenol cement, 98 with polyacrylic acid cement, and 98 with zinc phosphate cement. One hundred and twenty four patients had restorations cemented with more than one of the cements.

Five hundred and forty seven bridges and 162 single restorations were cemented. The distribution of the cements is shown in Table 1. The bridges in the study varied in length from 2-unit to 10-unit restorations. The highest single group of bridges was the 3-unit bridge of which there were 385. Details of other bridges are listed in Table 2.

Of the 441 patients in the study, 222 were recalled two or more times, 160 were recalled once, and 59 were not available for recall.

The success rate of cementation of single restorations is shown in Table 3. The success rate of cementation of all bridges is shown in Table 4. The failure of one retainer of a bridge is recorded as a bridge failure. Since a bridge usually involves two or more retainers no recognition is given to the other successful retainers. As we are concerned with the success of the cement in securing retainers, it is more meaningful to examine bridge success by recording retainers individually. The success rate for bridge

TABLE 2

LENGTH OF BRIDGES AND DISTRIBUTION OF CEMENTS

	2-Unit Bridge	3-Unit	4-Unit	5-Unit	6-Unit	7-Unit	8-Unit	10-Unit	Total
Zinc Oxide Eugenol	3	139	29	12	7	1	3	1	195
Polyacrylic Acid	7	128	36	13	7	1	1	0	193
Zinc Phosphate	3	118	28	6	3	0	1	0	159
Total	13	385	93	31	17	2	5	1	547

TABLE 3

SUCCESS RATE ALL SINGLE RESTORATIONS

	Total	Success	Percent
All Three Cements	162	159	98.1
Zinc Oxide Eugenol	57	56	98.2
Polyacrylic Acid	47	45	95.7
Zinc Phosphate	58	58	100

TABLE 5

SUCCESS RATE BRIDGE RETAINERS

	Total	Success	Percent
All Three Cements	1082	1049	96.9
Zinc Oxide	383	368	96.1
Polyacrylic Acid	388	374	96.4
Zinc Phosphate	311	307	98.7

retainers recorded individually is shown on Table 5.

The time interval from cementation to failure was recorded. Tables 6, 7 and 8 summarize the failures for the polyacrylic acid, zinc oxide eugenol, and zinc phosphate cement respectively. In the case of polyacrylic acid, of a total of eleven failures, 5 occurred in 6 months or less, 4 between 6 and 12 months, and 2 between 12 and 20 months. Of 16 failures with the zinc oxide eugenol cement, 1 failure occurred in less than 6 months, 13 failures occurred between 6 and 12 months, and 2 failures between 12 and 25 months. Of the three failures with zinc phosphate all occurred in the first 6 months.

A variety of restorations was used as bridge retainers in this study including complete crowns, three quarter crowns, M.O.D. inlays and pinledges. The success rates of these various bridge retainers will be the subject of a succeeding paper.

Discussion

Before inclusion in this study each patient was screened for willingness to cooperate and availability for recall; even so, 59 were either not available or were unwilling to return for reevaluation. Since the period available for the study was three years, the restorations placed early in the study were recalled more often than those placed later. The minimum period of observation was 6 months and the maximum about 30 months.

No limit was placed on the length of span or the location of restorations for inclusion in this study. Restorations listed as 2-unit bridges are almost exclusively splints placed in preparation for a clasp type partial denture. The preponderance of 3-unit bridges (385) in the sample reflects the most common type of case done in the Undergraduate Crown and Bridge Clinic. A fair number (141) of 4- to 6-unit bridges are present in the sample. Bridges spanning more than 6 units are rarely done in the Undergraduate Clinic.

Although the cementing media were assigned on a rotation basis the total welfare of the patient had to be considered. If the patient had a history of hypersensitive teeth or if pins had to be placed for retentive purposes and they were assumed to be in close proximity of the pulp organ then the rotation sequence was altered to select the most suitable cement for the case. The zinc oxide eugenol cement being sedative and the polyacrylic acid cement nonirri-

TABLE 4

SUCCESS RATE ALL BRIDGES

	Total	Success	Percent
All Three Cements	547	520	95.1
Zinc Oxide Eugenol	195	180	92.3
Polyacrylic Acid	193	184	95.3
Zinc Phosphate	159	156	98.1

TABLE 6

POLYACRYLIC ACID (PCA) FAILURES

Case No.	Time Period (Mo.)	Abutment Teeth & Units	Loose Abutment Tooth No.
3	11	7 (1)	7
121	8.5	3 (1)	3
268	1.5	12–14 (3)	12 & 14
307	4.5	4–6 (3)	4 & 6
316	2.5	2–6 (5)	6
334	20	18–20 (3)	18
372	4.5	19–21 (3)	19 & 21
443A	10.5	9–11 (3)	9
476	11	6–7–11 (6)	6,7,11
519	13	7–9 (3)	7
544	6	8–11 (3)	11

TABLE 7

ZINC-OXIDE-EUGENOL (ZEBACEM) FAILURES

Case No.	Time Period (Mo.)	Abutment Teeth & Units	Loose Abutment Tooth No.
Blue 3	8	29–31 (3)	29
Blue 8	4.5	29–31 (3)	29
Blue 30	7.5	11–14 (4)	11 & 14
86	25	11–13–15 (5)	11
105	24	29–31 (3)	31
131	9	18–20 (3)	18
193	8	30 (1)	30
205	9	23–24–26–31 (8)	23
206	8	27–29–32	32
252	7.5	13–15 (3)	13
275	7	11–14 (4)	11
308	11	6–9 (4)	6
326	8	29–31 (3)	31
443	10	6–8 (3)	6
484	7.5	18–20 (3)	20
523	7.5	11–13–15 (5)	11

tating, these two cements were used interchangeably when pulpal problems presented. The zinc phosphate cement was used only on cases where no deleterious pulpal responses were expected. When the rotation system was interrupted, attempts were made to keep equal numbers by assigning the omitted material more often on subsequent cases. No alteration in the rotation sequence was made due directly to retentive problems.

The success rate of bridges by cement used is summarized in Table 4. Note that the zinc oxide eugenol cement has the lowest success rate while the zinc phosphate cement has the highest success rate. When bridge retainers are considered as separate entities as in Table 5 the situation is similar.

TABLE 8

ZINC PHOSPHATE (TENACIN) FAILURES

Case No.	Time Period (Mo.)	Abutment Teeth & Units	Loose Abutment Tooth No.
408	5.5	18–20 (3)	18
542	6	7–8–11 (5)	7 & 8
547	9 days	9 rest 11 (3)	11

All the retainers of each of four bridges cemented with polyacrylic acid cement came loose. Of these, only one bridge had more than two abutments. Of the 15 bridges that failed when cemented with the zinc oxide eugenol cement, 4 had more than two retainers. Of the 3 bridges that failed when cemented with zinc phosphate cement only one had more than two abutments and on this bridge two retainers came loose.

Summary

A clinical trial for the final cementation of crowns and bridges with a reinforced zinc oxide and eugenol cement, a polyacrylic acid cement and a zinc phosphate cement was made over a 3-year period. The study involved 441 patients for whom 547 bridges and 162 single restorations were cemented. The patients were recalled at 6-month intervals for the duration of the study and the restorations were examined for looseness. Of the 547 bridges 520 remained firmly cemented to the abutment teeth. Of 1,082 bridge retainers, 1,049 remained in position; success and failure by types of retainer will be the subject of a subsequent paper. Of the 162 single restorations 159 remained in place.

Conclusions

The success rate of the three cements ranged from 95.7 to 100% for single restorations, from 92.3 to 98.1% for bridges, and from 96.1 to 98.7% for bridge retainers.

The difference in the ranges of success rates for the three cements was not regarded as being clinically significant. It appears that all three cements were equally successful as luting agents for fixed prosthesis when retainer types are not differentiated.

Reference

1. SILVEY, R.G., and MYERS, G.E.: Clinical Studies of Dental Cements: V. Recall Evaluation of Restorations Cemented with a Zinc Oxide-Eugenol Cement and a Zinc Phosphate. *J Dent Res* 55:289–291, 1976.