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The Solubility and Disintegration of some Dental Luting Cements

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SUMMARY

Five luting cements of types marketed fairly recently were tested for solubility and disintegration by a distilled water method prescribed in standards specifications. All five cements comply, by large margins, with the requirements of specifications. The clinical relevance of the distilled water test is discussed.

OPSOMMING

'n Gedistilleerde water metode wat deur standaard spesifikasies voorgeskryf word, is gebruik om voorbeelde van 5 kleefsemente wat onlangs bemark is, vir oplosbaarheid en ontbinding te toets. Al 5 semente voldoen ruimskoots aan die vereistes van die spesifikasies. Die kliniese toepaslikheid van die gedistilleerde watertoets word bespreek.

INTRODUCTION

Available technical methods do not permit the fabrication of dental restorations outside the mouth which will not expose the cementing medium to the influence of the oral fluids. Although meticulous craftsmanship may attain very high standards of marginal adaptation in such restorations the solubility and disintegration of cementing media is still considered sufficiently important to warrant the inclusion of tests of these characteristics in standards specifications for cements. For this reason it was considered that a comparison of the solubility and disintegration of some of the luting cements which have been marketed fairly recently would be of interest.

MATERIALS AND METHOD

The cements selected for testing were:-

A. A cement described by the makers as being "similar" to carboxylate cement and "Type I according to F.D.I. — Specification Nr. 6". The F.D.I. specification mentioned was for zinc phosphate cements and is now superseded by I.S.O. Recommendation R1566. (Fédération Dentaire Internationale, 1963 and International Organization for Standardization, 1970). The 2 specifications are technically identical and Type I refers to "Fine grain" zinc phosphate cements intended for "Accurate seating of precision appliances and other uses", with a maximum film thickness of 25 μm (misprinted as "minimum" in the I.S.O. document).
B. A cement described by the makers as a "carboxylate type cementing medium" and packed in capsule syringes.
C. A cement described by the makers as a "silicophosphate cementing medium" and packed in capsule syringes.
D. A zinc polycarboxylate cement which is offered with a choice of liquids (thick for bases or thin for cementation).
E. A zinc polycarboxylate cement, the consistency of which is varied by altering the powder/liquid ratio.

The batch numbers of the materials and their identities are shown in Table I.

The method used to test the solubility and disintegration of these cements was that described in I.S.O. Recommendation R1566 aforementioned (Paragraph 7.3.4). Briefly, the method involves making standard specimens of cement, in each of which a platinum wire of known mass is embedded (Fig. 1). Two specimens are placed in a weighing bottle of known mass and the combined mass of the bottle and specimens is determined. Subsequently the specimens are immersed in 50 ml of distilled water for the test period. After removal of the specimens the water is evaporated and the bottle is dried to constant mass. The weighings

TABLE I

Cement	Brand name	Manufacturer	Batch No.
A	Bondal	Vivadent, Schaan, Liechtenstein.	0611071
B	Bondalcap "C"	Vivadent, Schaan, Liechtenstein.	251171
C	Bondalcap "S"	Vivadent, Schaan, Liechtenstein.	151171
D	Durelon	ESPE, Seefeld/Oberbayern, West Germany.	475743 (powder) 021229 (liquid for cementation)
E	3M Polycarboxylate	3M Co., St. Paul, Minnesota, U.S.A.	2158 1F

make it possible to determine the gain in mass of the weighing bottle and the original mass of the specimens. Division of the first by the second and multiplication by 100 gives the solubility and disintegration, expressed as a percentage.

RESULTS

The results of the tests are set forth in Table II.

TABLE II

Cement	Percentage solubility and disintegration
A	0,0173
B	0,0016
C	0,5072
D	0,0493
E	0,0089

DISCUSSION

The maximum permissible solubility and disintegration specified in the I.S.O. Recommendation for zinc phosphate cements is 0,2 per cent (m/m) (International Organization for Standardization, 1970). It will be observed that cements A and B ("carboxylate type") and the zinc polycarboxylate cements D and E all have solubility and disintegration well within the limit prescribed for zinc phosphate cements.

The American Dental Association's Specification No. 21 for dental zinc silico-phosphate cement (American Dental Association, 1974) includes a test of solubility and disintegration which is technically identical with the test prescribed for zinc phosphate cements by the I.S.O. and the test is also used in the A.D.A. specifications for zinc phosphate and silicate cements (American Dental Association, 1974). However, in the A.D.A. specification for zinc silico-phosphate cement the limit of solubility and disintegration for a Type I (cementing medium) material is 1,5 per cent maximum. The capsulated silico-phosphate cement C is obviously quite acceptable by this standard, although more than 10 times as soluble as the carboxylate cement showing the highest figure. The weighing bottles used in testing the silico-phosphate cement C showed a marked deposit after drying (Fig. 2).

In view of the high solubility and disintegration in distilled water of the silico-phosphate material it is easy to conclude that such a material is unsuitable for use as a cementing medium. Easy, and probably most unwise.

The Council on Dental Materials and Devices of the A.D.A. takes the view that distilled water tests correlate with clinical experience when restricted to cements of the same class and also points out that one laboratory test cannot reproduce all the conditions which may be found in the mouth (American Dental Association, 1974, p. 52). Notwithstanding this clear implication of a restricted usefulness of distilled water tests it is often assumed that such tests are reliable predictors of the comparative clinical effectiveness of different cements. The limited value of dental specification tests of solubility and disintegration was mentioned by Wilson and Batchelor (1967). Eriksson and Stralfors (1970) repeat an opinion expressed earlier (Stralfors and Eriksson, 1969), that the A.D.A. distilled water test for silicate cements appears to be of little value. Recently Richter and Ueno (1975) have published the results of an investigation of the behaviour of 4 cements in clinical condition. The cements were a zinc silico-phosphate, a zinc phosphate, a ZOE-EBA and a zinc polycarboxylate. The authors state that, tested by the A.D.A. distilled water method for solubility, the cements rank as follows:- zinc polycarboxylate (least soluble), zinc phosphate, zinc oxide/eugenol and zinc silico-phosphate (most soluble). Under the conditions of the clinical test the zinc silico-phosphate cement performed best, while the zinc polycarboxylate was judged the poorest. This reversal, under clinical conditions, of the results of distilled water solubility tests, once again casts doubt upon the value of specification tests.

Griffith and Cannon (1974) have quoted the results of a lactic acid erosion test performed by K. Schmidt *et al.* This work indicates that, under the test conditions, which are not described, the solubility of carboxylate cements is nearly 4 times that of a zinc phosphate cement. It is suggested that in cases where acid producing plaque is present this could be a clinically significent factor. Under these test conditions cement C

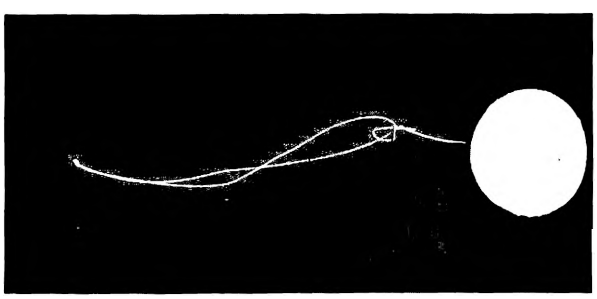


Fig. 1. Cement specimen disc.

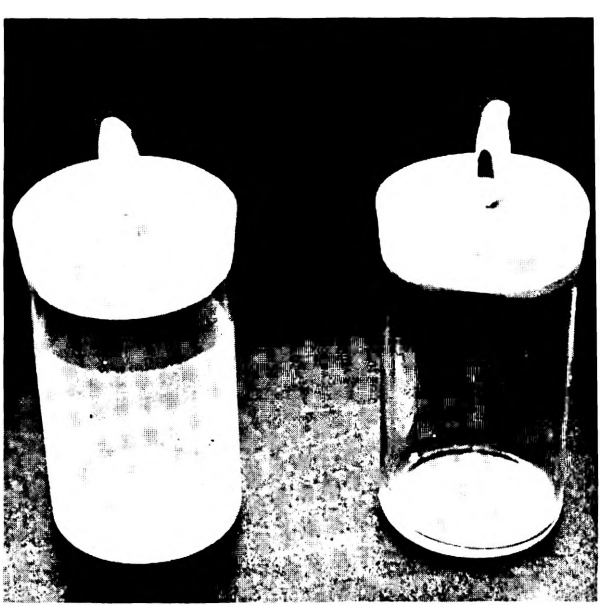


Fig. 2. Weighing bottles after drying.
On left, bottle used for silico-phosphate cement.
On right, bottle used for polycarboxylate cement.

(Bondalcap "S") was very much less soluble than polycarboxylate cements, again reversing the results of distilled water testing.

In conclusion it may be observed, firstly, that the 5 luting cements tested by specification method all meet specification requirements; secondly, that, in view of the limited value of the specification tests, it would seem desirable to develop test methods for solubility and disintegration which are clinically realistic and can serve as a basis for comparison of the merits of cements of different formulations.

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