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A COMPARATIVE EVALUATION OF COMPRESSIVE STRENGTH, TENSILE STRENGTH AND BOND STRENGTH OF VARIOUS DENTAL MATERIALS.

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ABSTRACT

Five different dental cements (Zinc-oxide, eugenol, Zinc Phosphate, polycarboxylate, Glass ionomer & silicophosphate) were selected for their compressive strength, tensile strength & bond strength measurements. The significantly positive correlation was observed between tensile & bond strength of all the dental cement samples. The compressive & bond strength of the cements (excluding Zinc Oxide eugenol) showed no correlation.
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Key Words: Zinc-oxide, eugenol, Zinc Phosphate, polycarboxylate, Glass ionomer ,silicophosphate, compressive strength, tensile strength and bond strength

INTRODUCTION

Strength properties of a luting agent defines its ability to resist disintegration during function. Adequate compressive strength ensures integrity of the adhesive joint under vertical functional load while tensile strength provides resistance against horizontal forces. Bond strength counteracts forces that tend to pull the adhesive joint apart. The correlation *between.* compressive strength and bond strength had been emphasized with zinc oxide eugenol and zinc phosphate cements only.(1) The diametral compression test(2) specified by the American Dental Association for testing tensile strength had served to exert a tensile force on the cement specimen resulting into pulling along its length. This closely resembles the method of testing bond strength which is interpreted in terms of resistance offered by the adhesive joint against a vertical displacement force. In this investigation it was envisaged to study a possible correlation between tensile strength, bond strength and compressive strength. Bond strength existed in case of other luting agents.

MATERIALS AND METHODS

Five luting cements namely zinc- oxide eugenol, zinc phosphate, polycarboxylate, glass ionomer and silicopbosphate were used in this study. Specimens for compressive, and tensile strength testing were prepared.as per specifications of the .American Dental Association (3)and for testing bond strength as performed earlier(4,5,6). Specimens were prepared at 23°C ± 2^{0}C and after a 24 hour storage at 37°C and

Table 1

1. Cements used for the study: Type	Commercial Name	Manufacturer
Zinc-Oxide Eugenol	Pennwalt ZOE Cement	S.S. White Dental Products Int. PA. 19102, USA.
Zinc Phosphate	Pennwalt Zinc Cement improved Type -1	do
Polycarboxyiate	Pennwal+PCA Cement	do
Glass-Ionomer	Ketac Cement	Espe Fabrik Pharma-zeutischer, Preparate GmBH Seefeld/Oberbay West Germany.
Silicophosphate	pennwalt FSuorothin Silicophosphate Type-1	S.S. White Dental Products Int. PA. 19102, USA.
2. Specimen Dimensions:		
(a)for Compressive strength test	Length 12.0±0.01 mm	ADA Specification No. 21
	Diameter 6.0i0.01 mm	ADA Specification No. 61
(b) for tensile strength Test	Length 3.0±0.01 mm	ADA specification
	Diameter 6.0+0.01 mm	No.9

Table -2

Cement Type	Compressive Strength (MPa)	Tensile Strength (MPa)	Bond Strength (MPa)
a) Zinc oxide-eugenol	11.41	3.12	237
b) Zinc Phosphate	1008	6.24	3.57
c) Polycarboxylate	58.26	9.71	3.94
d) Glass lonomer	61.03	13.93	3.88
e) Silicophosphate	141.32	5.72	3.48

100% humidity, were tested for compressive strength, tensile strength and bond strength. Each data recorded was the mean of results of testing five samples (under identical experimental conditions). Data thus obtained was subjected to statistical analysis for obtaining a possible correlation. Standard deviation for each property was derived/and coefficient of correlation was worked-out by the Karl Pearson's formula.

RESULTS AND DISCUSSION

The results of test samples i.e compressive strength, tensile strength and bond strength are

Table -3

Cement Type	Tensile strength (MPa)	Deviation from average (6.34)	Square of deviation	Bond strength (MPa)	Deviation from ave-rage(3.45)	Square of deviation	Product of deviations
Zinc-oxide eugenol	3.12	-3.22	10.37	2.37	-1.07	1.14	3.45
Zinc phosphate	6.24	-0.10	0.01	3.57	+0.12	0.01	0.01
Polycarboxylate	9.71	+3.56	12.10	3.94	+0.49	0.24	1.65
Glass-lonomer	6.93	40.58	0.34	3.88	+0.43	0.18	0.25
Silicophosphate	5.72	-0.62	0.38	3,48	+0.02	0.00	0.00
	ml =3172		x^2 =23.20	M^2 =17.24	y^2=1.57		5.35 -0.01
	n = 5			n=5			5.34

Average tensile strength = m_1/n =31.72/5 = 6.34 4.64

Average Bond strength = m_2/n = 17.24/5 = 3.45

Standard deviation of tensile strength O, = x^2/n =23.20/5 = 2.15

Standard deviation of bond strength O_2 =y^2 /n 1.57/5 = 0 .56

Substituting the above value in the Karl Pearson's formula =

xy/no_1o_2 = 5.34/5x2.5x0.56 = 5.34/6.02 = +0.89

Coefficient of correlation between tensile strength and bond strength = +0.89

presented in Table 2. It is clear that tensile strength and bond strength show a similar pattern. (linear resemblance) with respect to all the five cements. This is not true when these two properties are compared with compressive strength, which presents a similar trend only in case of zinc oxide-eugenol and zinc phosphate cement, as shown earlier[1]. Zinc oxide eugenol displayed poorest performance, with regard to all the three properties. Zinc phosphate and silicophosphate possessed high compressive strength but tensile strength was comparatively poorer. Polycarboxylate exhibits a compressive strength almost half, that of zinc phosphate but its tensile strength and bond strength values were the highest, followed by those of glass ionomer cement.

Detailed statistical analysis of data (Table 3.) showed a coefficient of correlation of +0.89 which proved a high degree of positive correlation between tensile strength and bond strength for all the cements used in this study. It is also clear that statistically bond strength, as a variable, was less sensitive in movement than tensile strength since a greater variation in the latter produced only minor increase or decrease in the former.

Strength properties of crystalline structures (like set cement) are related to the crystal lattice structure and resistance offered by it against forces of disintegration in a vertical (compressive) axis or longitudinal (tensile) axis.: Depending on the structure, the latter may offer great resistance when compressed, but not so, when pulled along the longitudinal axis. The tensile strength can be predictive of bond strength, since the experimental design for bond strength testing requires subjecting the adhesive joint to tensile forces. Variation in the present linear correlation between bond strength and tensile strength could be attributed to augmentation in bondage of cement to tooth. In case of polycarboxylate and glass-ionomer, which formed ionic linkages with dentin the bond strength was higher.

CONCLUSION

No correlation was found between compressive and bond strength except in case of Zinc-oxide eugenol and zinc phosphate. The significantly positive correlation coefficient (0.89) was observed between tensile and bond strength of all the study cement samples.

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