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Original Research Article

Comparative Evaluation of Transverse Strength of Provisional Restorative Resins Using Zinc Oxide Eugenol and Non Eugenol Cements - An in vitro Study

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ABSTRACT

A provisional restorative material must be strong enough to resist fracture during function. Fracture resistance of provisional restoration is an important concern for the restorative dentist and it is directly proportional to its transverse strength. The purpose of this in vitro study was the comparative evaluation of transverse strength of provisional restorative resins using zinc oxide eugenol and non eugenol cements.

Objective: An in vitro study was conducted to (a) Study the effect of zinc oxide eugenol cement on transverse strength of provisional restorative materials. (b) Compare the effect of zinc oxide eugenol cement versus non eugenol cement on the transverse strength of provisional restorative materials

Method: In the present study, 30 specimens of each material were obtained. They were coated with zinc oxide eugenol cement and non-eugenol cement ten specimens each. They were stored in water for 7 days and later were conducted to 3 point bending test. For comparison purpose the specimens were divided into 3 sub groups in each group. The control group, eugenol group and non eugenol group were the subgroups, and the results were statistically evaluated.

Results: All the specimen were subjected to three point bending test with universal strength testing machine at a cross head speed of 1mm / min to obtain fracture strength. The readings were recorded and transverse strength is calculated. The mean of the readings was obtained and comparison was done between the groups and within the groups.

Conclusion: The decrease in strength was highly significant for protemp composite resin followed by DPI self cure acrylic provisional resin. Zinc oxide eugenol cement in comparision to noneugenol cement affects the transverse strength of provisional restorative materials significantly.

Keywords: Flexural strength, provisional restorations, zinc oxide eugenol, non eugenol, resin cements

INTRODUCTION

A provisional restorative material must be strong enough to resist fracture during function. Fracture resistance of provisional restoration is an important concern for the restorative dentist and it is directly proportional to its transverse strength. Provisional crowns are essential in fixed prosthodontic therapy. Even though a definitive restoration may be placed as quickly as two weeks after tooth preparation, provisional restoration must satisfy the biologic, mechanical and esthetic requirements. Autopolymerizing resins are commonly used for making provisional restorations in fixed prosthodontic treatment. They are fixed to abutment teeth with a cementing agent that should have low strength and an obtundent effect on freshly prepared dentin. Zinc oxide-eugenol cement is popular because it has low strength and is an obtundent. The use of zinc oxide and eugenol in conjunction with composite resins is not recommended, since eugenol is an inhibitor of polymerization. Curing of composite resins against ZOE reduces their transverse bending strength and brings about a small decrease in hardness. [1-3]

OBJECTIVES:

Objectives of this study are

1) To study the effect of zinc oxide eugenol cement on transverse strength of provisional restorative materials.

2) To compare the effect of zinc oxide eugenol cement versus on eugenol cement on the transverse strength of provisional restorative materials

METHODOLOGY

Specimen fabrication: Three commercially available provisional resins were used for the study (Photograph No.3). Disks of resin (20mm in diameter and 2mm thick) were made in a mold sandwiched between sheets of glass (Photograph No. 5) for group I and group II. Disks were allowed to cure in water bath for 5 minutes, after which the glass was removed and disks were further cured in air for 15 minutes. Group III includes heat cure provisional acrylic resin. Standardized wax specimens were made flasked, dewaxed and acrylized. A cementing agent (Photograph No. 4) was mixed according to manufacturer's instructions and placed on the cured resin. The thickness of cement was controlled by 0.25mm spacer and glass plate. 10 discs were made for each resin / cement combination. All specimens were stored in an atmosphere of 100% humidity at 370C for 7 days. After one week, the cement was removed with moist cotton swab16 and a blunt instrument17. The fracture strength of each specimen was measured using 3 point bending test with universal strength measuring machine (Photograph No.8a and 8b). The fracture strength values obtained were tabulated and were used to derive the transverse strength values of the specimens. These specimens were fractured and the fractured site was evaluated microscopically under a magnification of 400 X (Photograph No. 9a, 9b).

Figure:1 Acrylizer used in the Study

Figure:2 Resin materials used

Figure:3 Cements used in the study

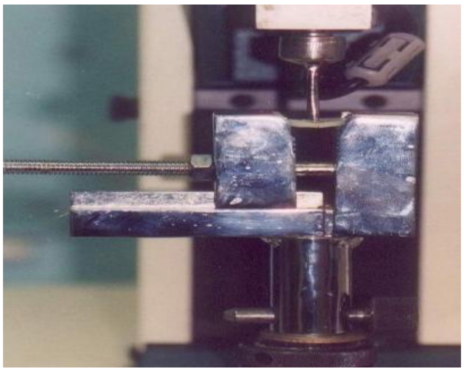

Figure:4 Specimen under evaluation

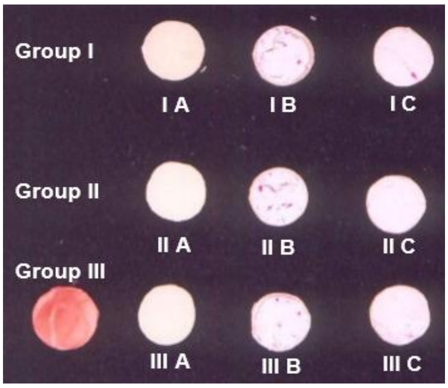

Figure: 5 Provisional resins of the three groups

RESULTS

The specimens were fabricated in the following manner.

Group I – D.P.I Self cure provisional acrylic resin was used.

IA : Specimens without any cement. (Control group)

IB : Specimens with Zinc oxide eugenol cement.

IC : Specimens with non eugenol cement.

Group II : Protemp Bis-acrylate provisional composite was used.

II A : Specimens without any cement (control group)

II B : Specimens with Zinc oxide eugenol Cement .

II C : Specimens with non eugenol group.

Group III : D.P.I Heat cure provisional acrylic resin was used.

III A : Specimens without any cement (control group)

III B : Specimens with zinc oxide eugenol cement.

III C : Specimens with non eugenol group.

All the specimen were subjected to three point bending test with universal strength testing machine at a cross head speed of 1mm / min to obtain fracture strength. The readings were recorded and transverse strength is calculated with the following formula.

$S_T = 3L / 2 bh^2 P$

Where,

P = Fracture load

L = Sample length between two supports. (20 mm).

B = Sample width (20 mm).

h = Sample thickness (2 mm).

ST = 0.3 P

The mean of the readings was obtained and comparison was done between the groups and within the groups

Table 1: Showing fracture strength (Kg) values of specimens coated with zinc oxide eugenol cement and the calculated transverse strength values in Newton.

Specimen	DPI selfcure (Kg)	Protemp II composite (Kg)	DPI heatcure (Kg)	Specimen	DPI selfcure (N)	Protemp II composite (N)	DPI heatcure (N)
1	17.32	12.8	25.24	1	50.92	37.63	74.21
2	15.86	14.92	23.30	2	46.63	43.86	68.50
3	14.56	13.36	24.67	3	42.81	39.28	72.53
4	15.06	14.56	26.02	4	44.28	42.81	76.50
5	14.34	13.15	26.41	5	42.16	38.66	77.65
6	17.56	11.21	24.08	6	51.63	32.96	70.80
7	16.91	11.01	26.49	7	49.72	32.37	77.88
8	15.06	14.46	22.30	8	44.28	42.51	65.56
9	17.49	14.04	25.55	9	51.42	41.28	75.12
10	15.39	16.01	23.94	10	45.25	47.07	70.38

Table 2: Showing fracture strength (Kg) values of specimens coated with non eugenol cement and the calculated transverse strength values in Newton.

Sl. No.	DPI self cure (Kg)	Protemp II composite (Kg)	DPI heatcure (Kg)	Sl. No.	DPI self cure (N)	Protemp II composite (N)	DPI heat cure (N)
1	24.64	24.58	29.61	1	72.44	72.27	87.05
2	22.91	28.93	31.49	2	67.36	85.05	92.58
3	25.66	27.82	32.78	3	75.44	81.79	96.37
4	24.68	24.61	31.14	4	72.56	72.35	91.55
5	25.99	29.01	29.66	5	76.41	85.29	87.20
6	24.64	29.05	32.14	6	72.44	85.41	94.49
7	26.01	23.87	31.36	7	76.47	70.18	92.20
8	25.69	22.67	29.7	8	75.53	66.65	87.32
9	25.93	25.67	29.82	9	76.23	75.47	87.67
10	26.09	28.67	30.78	10	76.70	84.29	90.49

Table 3: Showing fracture strength (Kg) values of specimens (control group) and the calculated transverse strength values in Newton.

Sl. No.	DPI self cure (Kg)	Protemp II composite (Kg)	DPI Heat cure (Kg)	Sl. No.	DPI Self cure (N)	Protemp IIcomposite (N)	DPI heat cure (N)
1	31.34	28.01	31.14	1	92.14	82.35	91.55
2	30.64	32.48	32.04	2	90.08	95.49	94.20
3	27.04	31.09	30.69	3	79.50	91.40	90.23
4	27.89	28.99	30.59	4	82.00	85.23	89.93
5	31.5	29.07	28.93	5	92.61	85.47	85.05
6	30.89	30.98	29.43	6	90.82	91.08	86.52
7	28.77	30.81	31.04	7	84.58	90.58	91.26
8	29.67	32.98	32.33	8	87.23	96.96	95.05
9	29.87	30.84	32.44	9	87.82	90.67	95.37
10	31.34	31.48	31.59	10	92.14	92.55	92.87

Table 4: Showing transverse strength values of subgroup I_B and I_C with I_A [control group].

Sl. No.	Control	Eugenol group	Non eugenol group
1	92.14	50.92	72.44
2	90.08	46.63	67.36
3	79.50	42.81	75.44
4	82.00	44.28	72.56
5	92.61	42.16	76.41
6	90.82	51.63	72.44
7	84.58	49.72	76.47
8	87.23	44.28	75.53
9	87.82	51.42	76.23
10	92.14	45.25	76.70
Mean	87.89	46.91	74.16
S.D	4.57	3.69	2.97
Minimum	79.50	42.16	67.36
Maximum	92.61	51.63	76.70

The mean measurement for control group (IA) was calculated to be 87.89 N.

Sub Group I B was indicating a mean value of 46.91 N (Range 42.16N – 51.63 N and S.D. +/-.69 N).

Sub Group I C was indicating a mean value of 74.16N. (Range 67.36 N – 76.70 N and S.D. +/- 2.97 N).

Table 5: Showing transverse strength values of subgroup II_B and II_C with II_A (control group).

Sl.No.	Control	Eugenol group	Non eugenol group
1	82.35	37.63	72.27
2	95.49	43.86	85.05
3	91.40	39.28	81.79
4	85.23	42.81	72.35
5	85.47	38.66	85.29
6	91.08	32.96	85.41
7	90.58	32.37	70.18
8	96.96	42.51	66.65
9	90.67	41.28	75.47
10	92.55	47.07	84.29
Mean	90.18	39.84	77.87
S.D	4.60	4.67	7.25
Minimum	82.35	32.37	66.65
Maximum	96.96	47.07	85.41

The difference between sub group I A (control) and sub group I B and I C was statistically significant. When differences were compared between the sub groups (A, B,C) applying one-way ANOVA followed by Newman-Keul's range test, the sub groups differed significantly ($P < 0.1$). Sub group I B shows the highest difference from sub group IA (control).

The mean value for control group (II A) was calculated to be 90.18 N. Sub group II B exhibited a mean value of 39.84 N (Range 32.37 N – 47.07 N, S.D. +/- 4.67 N). Sub group II C exhibited a mean value of 77.87 N (Range 66.65 N – 85.41N, S.C. +/- 7.25 N).

The difference between control group (II A) and group II B and II C was statistically significant. Sub group II B showed highest difference from control group.

Table 6: Showing transverse strength values of subgroup III_B and III_C with III_A (control group).

Sl. No.	Control	Eugenol group	Non eugenol group
1	91.55	74.21	87.05
2	94.20	68.50	92.58
3	90.23	72.53	96.37
4	89.93	76.50	91.55
5	85.05	77.65	87.20
6	86.52	70.80	94.49
7	91.26	77.88	92.20
8	95.05	65.56	87.32
9	95.37	75.12	87.67
10	92.87	70.38	90.49
Mean	91.20	72.91	90.69
S.D	3.44	4.10	3.32
Minimum	85.05	65.56	87.05
Maximum	95.37	77.88	96.37

The mean value for control group (III A) was calculated to be 91. 20 N. Sub group III B exhibited a mean value of 72. 91 N.(Range 65.56 N – 77. 88 N, S.D. +/- 4.10 N).

Sub group III C exhibited a mean value of 90.69 N. (Range 87.05 N – 96.37 N. S.D +/- 3.32 N).

The difference between control group (III A) and only Sub group III B was statistically significant but not group III C.

Formulae used in the study

1) Mean

$$(\bar{X}) = \frac{\sum Xi}{N}$$

Where Xi = 1, 2 ………….n

n = Total number of samples studied.

2) Standard deviation

$$(SD) = \sqrt{\frac{\sum (\bar{X}i - X)^2}{n - i}}$$

3) Variance = SD2

4) One-way ANOVA

$$F = \frac{\text{Between group variance}}{\text{Within group variance}}$$

5) Student –Neuman-Keuls Test,

Minimum significant range,

$$K = K^{*} \sqrt{\frac{V_e}{Nm}}$$

K* = Table value

Ve = Error variance

Nm = Sample size

DISCUSSION

Provisional restorations are used as diagnostic aids when correcting irregular occlusal planes, altering vertical dimension or planning for changes in the location and contour of gingiva or the size, shape and colour of the final restoration. In complex treatment, provisional restorations are an integral part of treatment planning process and must maintain their integrity throughout the diagnostic and restorative phases. Vahidi [4] and others identified multiple areas of critical concern with provisional restorations including esthetics, comfort, speech and function, periodontal health, maxillomandibular relationships and continued evaluation of the fixed prosthodontic treatment plan. However, interim treatment has to function for extended intervals and provide long term tooth protection and stability while adjunctive treatment is accomplished. These objectives depend on important physical properties of resins including polymerization shrinkage, wear resistance, color stability and strength. In long-span provisional restorations, strength is a critical property. When masticatory forces are applied to long-span provisional restoration fracture of the restoration is more likely than with a short-span restoration. The transverse strength test is a combination of tensile and compressive strength tests and includes elements of proportional limit and elastic modulus measurements. The transverse strength of provisional restorations is important particularly when the patient must use the provisional restoration for an extended period, when the patient exhibits Parafunctional habits, or when a long-span prosthesis is planned. [5] Three types of chemically polymerized materials are commercially available for provisional restoration of single and multiple units. These include ethyl methacrylates, methyl methacrylates and bis-acryl resin composites. Historically, ethyl methacrylates have shown poor wear resistance and poor esthetics. Thus, the methyl methacrylates and bis-acryl resin composite materials possess a larger market share. [6] The filled or composite resins have enjoyed immense success with dental profession as anterior proximal restorative materials. Since it is obvious that eugenol containing provisional cements or endodontic sealers effect the mechanical properties of resins in contact with them. [7-9,1,10] In group I (DPI self cure provisional acrylic resin), in comparison to control group, other two subgroups showed statistically significant deviation. But eugenol group (IB) showed more deviation. Similar trend was observed with group II (Protemp bisacrylate provisional composite). When compared to control group other subgroups showed statistically significant deviation of which eugenol group (IIB) was more significant. In group III (DPI heat cure provisional acrylic resin) only the eugenol group (IIIB) showed a statistically significant deviation but not noneugenol group (IIIC) The reason for these decreased transverse strength values of eugenol group may be due to inhibition of polymerization by the free eugenol in the cement applied on the specimens. [7,2,11] The other reason may be due to roughness of the surfaces of resin cured against ZOE cement created due to occurrence of a chemical reaction or by mutual dissolution of the components at the interface. A rough surface may enhance crack initiation, which could be especially deleterious to the bending strength of the resin." A comparison was done between the three materials used, heat cure acrylic resin showed minimum decrease in strength in comparison to other two groups (self cure provisional acrylic and composite resins) in both eugenol and non eugenol groups. The reason for this variation could be due to the degree of polymerization. When comparison was done with in specimens luted with non eugenol group, highest values of transverse strength were shown by heat cure provisional acrylic resin which was statistically significant. The difference between values of transverse strength of the other two groups i.e. D.P.I. self cure provisional acrylic resin and protemp bis-acrylate provisional composite was not statistically significant as they had mean values of 74.16N and 77.87N respectively. The reason for the little higher strength of bisacrylate provisional composite may be attributed to differences in chemical composition. [5] Based on the results of study, it can be suggested DPI heat cure provisional acrylic can be used with either eugenol or noneugenol cement when provisional prosthesis is expected for long time followed by protemp composite resin luted with non eugenol cement.

SUMMARY AND CONCLUSION

Within the conditions of the study, the following conclusions were drawn.

1) The provisional restorative resins when luted with zinc oxide eugenol cement showed a significant variation in their transverse strength values. The decrease in strength was highly significant for protemp composite resin followed by DPI self cure acrylic provisional resin.

2) Zinc oxide eugenol cement in comparision to noneugenol cement affects the transverse strength of provisional restorative materials significantly

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