

A comparative study on the retention of full coverage cast crowns cemented with zinc phosphate cement with and without die relief agent on prepared human teeth

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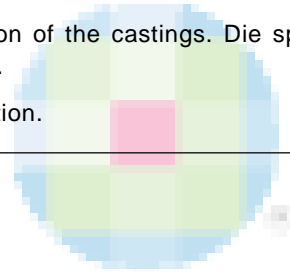
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Purpose of study: The purpose of this study is to analyze the effect of die spacer on retention of full coverage crowns. The success of a full cast crown restoration depends on the marginal fit and the retention of the restoration. The application of die spacer helps to improve the fit of the crown, but its effect on postcementation retention has been a subject of controversy. The present study was undertaken to compare the retentive force required to dislodge the unspaced and spaced crowns.

Methodology: Twenty-five freshly extracted molar teeth were prepared and two stone dies were prepared for each tooth. One die from each pair was coated with four layers of die spacer. A pair of castings was obtained for each tooth. Force required to dislodge the cemented castings was measured using a constant displacement-rate-testing machine.

Conclusion: Die spacer reduces the retention of the castings. Die spacing must be used carefully to maximize its potential and eliminate the loss of retention.

Key words: die spacer; internal relief; retention.



Optimum retention is a fundamental requisite for a full cast crown restoration. Tooth preparations are designed and the restorations are made to fit the prepared tooth intimately. But the tight fit of the crown and the viscosity of the cement prevent the complete seating of the restoration.

Many methods have been suggested to improve the seating of castings by relief of the hydrodynamics of cementation like venting and internal relief.^[1]

Venting or perforating the crown occlusally has some serious disadvantages. Various methods for achieving internal relief are mechanical grinding, carving of wax pattern, and etching with aqua regia, electrochemical milling, and die spacing.^[2]

It is highly desirable that the marginal opening of a crown could be reduced considerably without making any alteration of the casting.^[2]

More complete seating during cementation is the prime benefit of die spacing. But the fit of the casting is gener-

ally thought to mean that it is both retentive and well seated. Role of the die spacer on retention of the castings is still controversial.

Eames et al.^[3] suggested 25 mm of casting relief. Fusayama et al.^[4] implied that less than 30 mm was undesirable.

The purpose of the study was to know the effect of a commercial die relief agent on the retention of castings cemented with zinc phosphate cement.

MATERIALS AND METHODS

The present study was conducted *in vitro* on 25 freshly extracted human molar teeth. The teeth were cleaned with normal saline and then stored in artificial saliva throughout the course of the experiment. Each tooth was stabilized in autopolymerizing resin approximately 2 mm below the CE junction.

Each tooth was prepared for a full coverage cast resto-

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ration [Figure 1]. Two special trays were made of self-cure acrylic resin, and two impressions of each prepared tooth were made [Figure 2] using polyvinyl siloxane impression material. The impressions were poured with die stone plaster to secure a pair of the dies after setting.

The walls of one of the dies of every specimen were coated to within 0.5 mm of its cervical margin with four layers of die spacer (Tru-Fit, George Taub Products, Jersey City, NJ, USA) in alternate layers of silver and gold, with 5 min of drying time between each application. The other die of the same specimen was not coated with die spacer [Figure 3].

The dies were given an even application of the die lubricant and dipped in molten blue inlay wax type 1 (Bego) in a wax bath. The thickness of the wax pattern was kept at 1 mm and was measured using a wax-measuring gauge at four points. A loop was attached to the wax pattern to facilitate the removal of casting during testing.

A conventional lost-wax-casting technique using Nickel Chromium casting alloy was used to fabricate the castings. The castings were refined and polished and checked for their fitness, first on stone dies [Figure 4] and then on the prepared tooth.

The same procedure was repeated for the remaining 24 teeth.

The unspaced casting was cemented first. Moderate finger pressure was used and then a static load of 5 kg for 10 min was applied to the casting. The specimens were again kept in artificial saliva for 24 h.

After 24 h the crown – tooth – pulling attachment assembly was centered in the Instron Universal Testing Machine [Figure 5]. Force required to dislodge the unspaced casting was measured at a crosshead speed of 0.02 in./min. Then the spaced casting was cemented and the same procedure was repeated. The same procedure

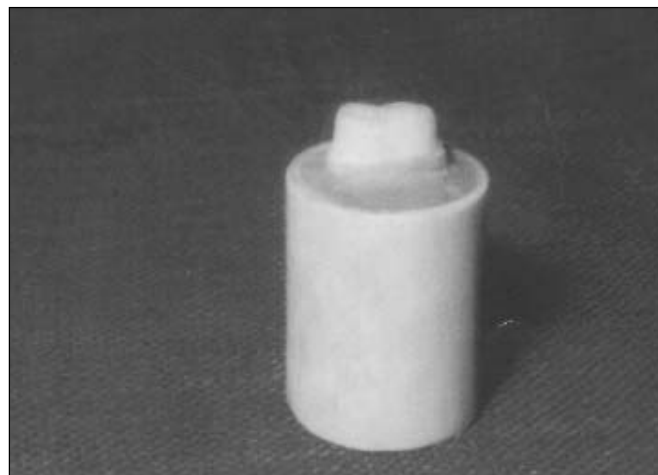


Figure 1:

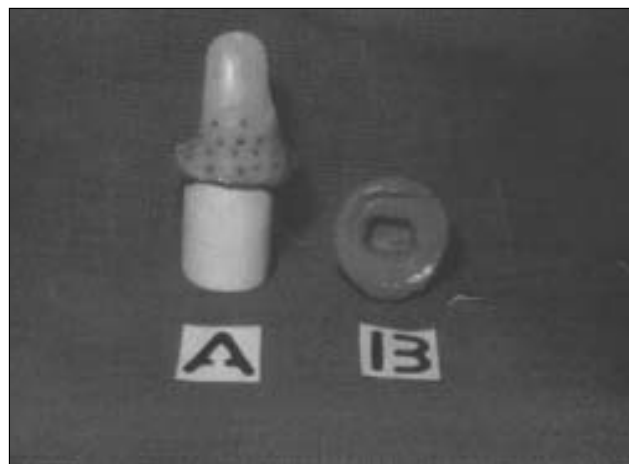


Figure 2:

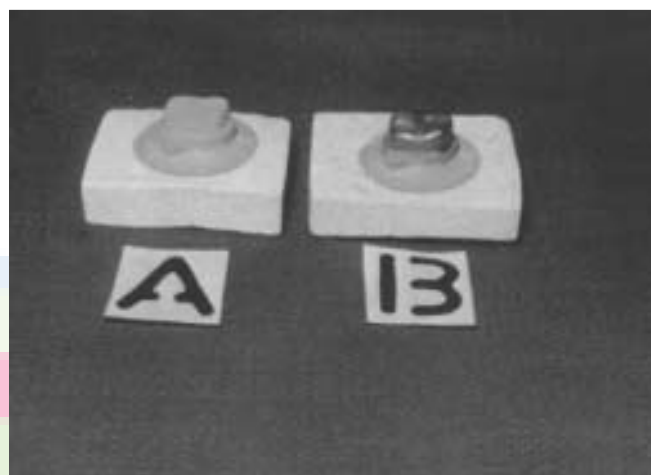


Figure 3:

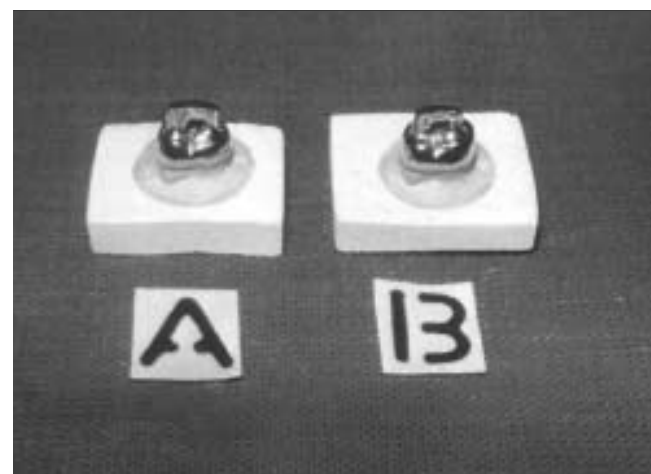


Figure 4:

was repeated for the remaining teeth. The amount of force required to dislodge the cemented spaced and unspaced castings was recorded and used for statistical analysis.

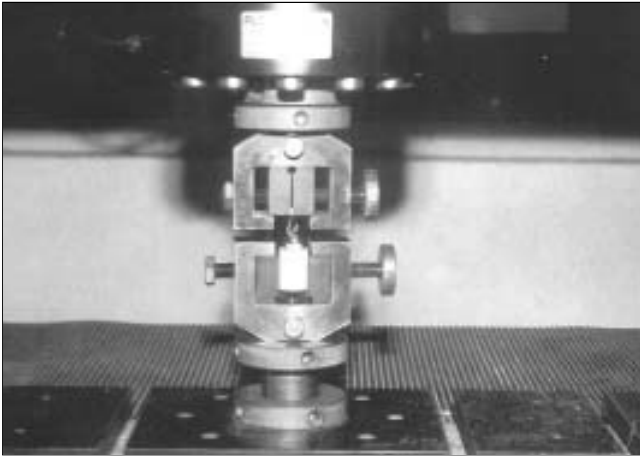


Figure 5:

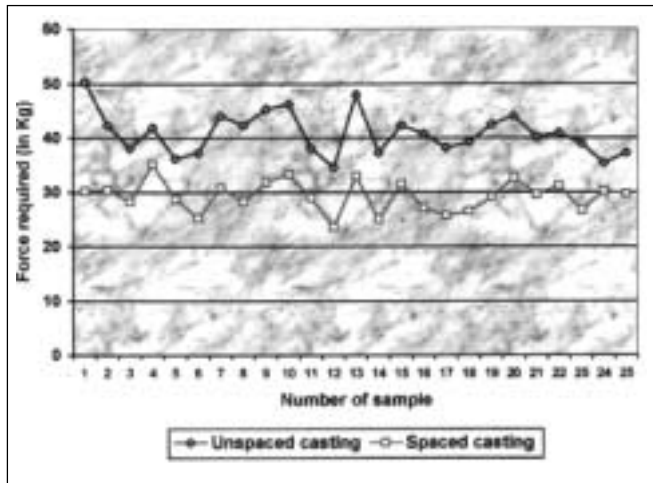


Figure 6:

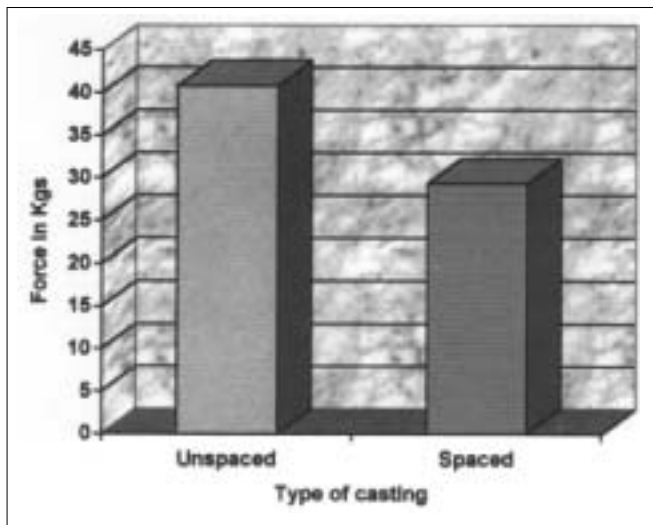


Figure 7:

Table 1: Force required (in kg) to dislodge cemented castings

Sample No.	Unspaced casting	Spaced casting
1	50.37	30.20
2	42.30	30.46
3	38.00	28.22
4	41.90	35.14
5	36.20	28.74
6	37.19	25.24
7	44.10	30.76
8	42.32	28.30
9	45.78	31.80
10	46.23	33.30
11	38.11	29.00
12	34.50	23.60
13	48.00	32.90
14	37.24	25.10
15	42.34	31.42
16	40.70	27.12
17	38.19	25.74
18	39.12	26.50
19	42.40	29.10
20	44.00	32.62
21	40.20	29.58
22	40.82	31.14
23	38.90	26.70
24	35.34	30.25
25	37.20	29.71

Table 2: Force required (in kg) to dislodge cemented castings

Type of casting	Number of observations	Range	Mean
Unspaced	25	34.50–50.37	40.86
Spaced	25	23.60–35.14	29.31

Table 3: Basic statistics

Method	Number of observations	SD	CV%	SE Of mean	Confidence interval 95%	Confidence interval 99(%)	Force %
1	25	3.94	9.6	0.80	39.20–42.52	38.61–43.11	100.0
2	25	2.79	9.5	0.57	28.13–30.48	27.71–30.90	71.7

SD, standard deviation; CV%, coefficient of variation in percentage; SE, standard error.

Table 4: Relation coefficient and paired t-values between methods 1 and 2

Method 1	Method 2	Correlation coefficient	t-Statistic (for methods 2-1)	Nature
1	2	0.65	-18.81	Highly significant

Statistical analysis

Various statistical measures such as standard deviation (SD), coefficient of variation (CV in percentage) and standard error (SE) of mean were computed for the two methods. Statistical analysis was done by the Student's paired 't' test to determine whether there were any significant differences in the mean forces required for the two methods.





RESULTS

The use of die spacer resulted in 28.3% reduction in force required to remove the casting. That is to say the mean force required to dislodge unspaced casting is significantly greater in comparison to the force required to dislodge spaced casting.

DISCUSSION

Accurate seating of complete veneer cast crowns during cementation is a difficult procedure. Die spacer provides space for cement thickness and thus helps in seating.

The ideal thickness of die spacer has not been scientifically established. The general accepted range is approximately 20–40 mm. According to ADA specification No. 8 for zinc phosphate cement type 1,^{[5],[6]} 25 mm is the maximum limit for the film thickness. Rieger et al.^[7] found that four layers of die spacer applied in a sequence of silver-gold-silver-gold, provided a relief of 23.93 mm.

Jorgensen^[8] reported that compressive load applied during cementation also affects the cement thickness and an increase in load above 5 kg will not produce much difference. So a load of 5 kg was applied for 10 min.

Carter et al.^[9] compared the force required to remove the crowns before and after cementation and found that precementation frictional retention or initial mechanical grip decreased with increasing layers of die spacer.

Previous studies have shown that the retention of the restoration will be improved, unchanged, or reduced when an appropriate thickness of die spacer was used. Vermilyea et al.^[10] found that the mean force required to dislodge unspaced casting was more. Also Gegauff and Rosenstiel^[11] observed that retention without spacer was greater. Marker et al.^[12] got variable results. However Passon et al.^[13] found that die spacer did not affect the retention even when applied up to 16 coats.

The significant reduction in the retention, as noted in this study may indicate the predominance of different forces with the cement films under each casting condition. Shear strength–tensile strength ratio of zinc phosphate cement (6 : 1) suggests that failure of relatively thin layers of zinc phosphate cement is mainly the result of shear forces while the failure of thicker films is the

result of tensile forces. High shear strength provided by the zinc phosphate cement, may be negated by the cementation of oversized castings fabricated from relieved dies.^[10]

The clinical significance of *in vitro* studies should be re-evaluated to assess more clearly the benefit of die-spacing procedures.

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