

# Comparative evaluation of retention of lithium disilicate crowns with four different cementation systems- An in-vitro Study

Dr. Dhaniram Talukdar<sup>1</sup>, Dr. Bharti Dua<sup>2</sup>, Dr. Pankaj Datta<sup>3</sup>, Dr. Anupam Bhardwaj<sup>4</sup>

<sup>1</sup>Senior Lecturer, Department Of Prosthodontics, Divya Jyoti Dental College, Modinagar,

<sup>2</sup>Senior Lecturer, Department Of Prosthodontics, Santosh Dental College, Ghaziabad.

<sup>3</sup>Prof and Head, Department of Prosthodontics, Inderprastha Dental College, Sahibabad,

<sup>4</sup>Senior Lecturer, Department of Oral & Maxillofacial Prosthesis, Santosh Dental College, Ghaziabad

DOI: 10.47750/pnr.2022.13.S06.146

## Abstract

**AIM OF THE STUDY:** This in vitro study was performed to compare the retention of pressable lithium disilicate crowns cemented with four different cementation systems.

**METHODS:** Eighty single rooted maxillary 1st premolars were collected after excluding teeth with caries and/or previous restorations. Preparation of the samples was standardized by using a diamond bur mounted onto a surveyor. An anatomic crown was waxed on each tooth and then hot pressed using lithium disilicate ceramic (IPS e.max PRESS, IvoclarVivadent). The samples were randomly divided into 4 groups (n = 20) according to different cementation systems. Each group sample was subjected to a seating force of 50N using universal testing machine. Each upper block was pulled along the path of insertion of the crown with a crosshead speed of 1mm/min.

**RESULTS:** Self adhesive resin cement showed the maximum tensile strength among all adhesive luting cements (2.65 MPa). Self etch resin cement group showed mean tensile strength of (1.78 MPa) that was marginally less than total etch resin cement (1.86 MPa). Glass ionomer cement exhibited least tensile strength (1.41 MPa) compared to the other three luting cements.

**CONCLUSION:** Within the limitations of this in vitro study, it was concluded that lithium disilicate full coverage crowns cemented with self adhesive resin cement showed higher bond strength followed by total etch resin cement, self etch resin cement and glass ionomer cement.

**Keywords:** Lithium disilicate, Self adhesive resin cement, Self etch resin cement, Total etch resin cement, Glass ionomer cement, Self cure acrylic resin.

## INTRODUCTION

Restorative dentistry has modified treatment planing in several aspects due to the myriad of options available for fabricating indirect restorations which have come up over the past few decades, especially pertaining to ceramics and resin cements.<sup>1</sup>

Ceramic is a solid mixture (metal and non-metal elements) with crystalline structure. Restorations with high crystalline content are very popular due to high esthetic value and increased mechanical properties compared to metal frameworks fused to ceramic (PFM) crowns.<sup>2</sup> They are strong, inert, and stable at high temperature and have good optical properties to provide esthetic results.<sup>3</sup>

Despite the fact that for most of the fixed restorations, PFM (Porcelain fused to metal) option is used, the market interest is drifting towards greater use of all-ceramic.

All-ceramic systems provide better esthetic advantage than PFM restorations; since the blackish hue of the metal is replaced by ceramic material with variable degree of value (opacity-translucency), which helps in achieving better esthetic results with certainty. Also, many a times the emergence profiles of PFM restorations are over contoured because a large amount of ceramic,

which is required to camouflage the metallic hue. However, this is not the case with all-ceramic system. All ceramic restorations are prepared with finish line at the level of gingival margin or many a times supra-gingival which makes the impression making simple and causes minimal trauma to gingival tissue.

Although ceramics have many advantages, ceramics are found to be fragile under tensile strain. This weakness can be attributed to the presence and propagation of micro flaws present on the surface of the material, making the ceramic susceptible to fracture, making the cementation process vital for the clinical success of all ceramic restorations.<sup>4</sup>

Although ceramics have many advantages, ceramics are found to be fragile under tensile strain. This weakness can be attributed to the presence and propagation of micro flaws present on the surface of the material, making the ceramic susceptible to fracture, making the cementation process vital for the clinical success of all ceramic restorations.<sup>5</sup>

Dental cements are joining medium which provides adhesion or micro-mechanical attachment to the surfaces to be joined, like indirect restorations and tooth surface. They are very relevant in clinical dentistry since any restoration fabricated in the dental lab (metallic and non-metallic crowns and bridges) must be cemented with 'luting cement'.

The most important functions of the luting cements in fixed prosthodontics are; to be esthetic, provide an effective marginal seal, provide thermal insulation and mechanically lute the fabricated restoration in its desired place, so as to avoid any displacement while in function.<sup>7</sup>

Clinicians should know the characteristics of dental cements, along with the surface qualities of the material for indirect restoration. Like in all-ceramic restoration the material may range from glass ceramic to polycrystalline ceramic which may require different kinds of luting agents for better results. It was also found that fresh teeth without contamination with microorganisms are required for the highest possible resin dentin bond strength.<sup>8</sup>

Thus, for adequate luting, cement selection and manipulation is very critical.

The luting of indirect restoration to abutments is the final critical step in achieving proper performance of indirect restoration.<sup>9</sup>

But not all the available luting cements are ideal for all situations.

A low frequency of post-operative sensitivity was reported for self-etching resin cement, which are less technique-sensitive than total-etch resin cement<sup>10</sup>. All ceramic restorations do benefit from resin cements bonding to the tooth. Hence it necessitates comparing the bonding ability of different luting cements to ceramic and dentin.

Thus this in vitro study was taken up with the objective to compare the retention of pressable Lithium Disilicate Ceramic crown with four different luting agents (glass ionomer cement, self etch resin cement, self adhesive resin cement and total etch resin cement)

## METHODOLOGY

This experimental study was conducted at Department of Prosthodontic and Crown & Bridges, Inderprastha Dental College and Hospital, Uttar Pradesh, India, to compare the retention of pressable lithium disilicate ceramic crown with four different luting cements. Eighty single rooted extracted maxillary 1st premolar teeth were taken for the study. Cylindrical samples of acrylic block with dimension 40 mm X 14 mm were obtained from a master mould of stainless steel (Figure 1). The master metal mould was prepared in two halves, wherein one of the halves could be slid manually on a base to approximate the other half to enclose a cylindrical cavity of 40 mm X 14 mm. (Figure 2). Care was taken to mount these teeth in the center of the jig. During mounting teeth in resin, care was taken to expose the anatomical crown of the teeth (CEJ) as well as tooth surface up to 2mm below CEJ. The root portion was completely embedded in acrylic. Preparation of the teeth was standardized using a diamond bur mounted onto a surveyor (Figure 3). Each tooth was prepared for a 1.25 mm circumferential chamfer and a total occlusal convergence angle of 10 degrees between axial walls. The finishing line was placed at the CEJ level. An anatomic crown was waxed on each tooth and then hot pressed using lithium disilicate ceramic and monolithic crowns were fabricated. The samples fabricated were divided into following 4 groups-

Group A: Glass ionomer cement

Group B: Self etch resin cement

Group C: Total etch resin cement

Group D: Self Adhesive resin cement

Each group samples was subjected to on seating force of 50N using universal testing machine. Screw base was incorporated in autopolymerizing acrylic resin block with long axis parallel to the long axis of the tooth. Each upper block was pulled along the path of insertion of the crown with a crosshead speed of 1mm/min. Retention was investigated by using universal testing machine ((MECH/No: 75). The tensile force values of the specimens were calculated in megapascals (Mpa).



Figure1: Master metal mould for cylindrical specimens



Figure 2: Master metal mould in two parts



Figure 3: Surveyor with handpiece for tooth preparation

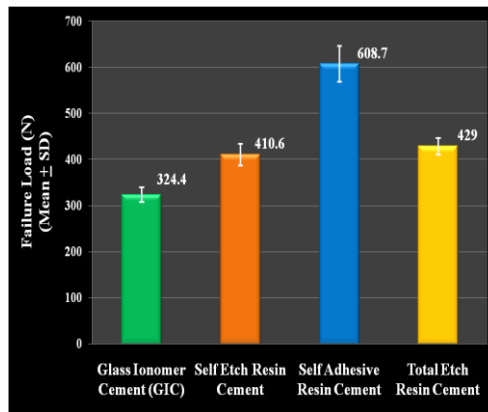


Figure 4. Mean failure load (N) of pressable lithium disilicate ceramic crowns luted with different luting agents.

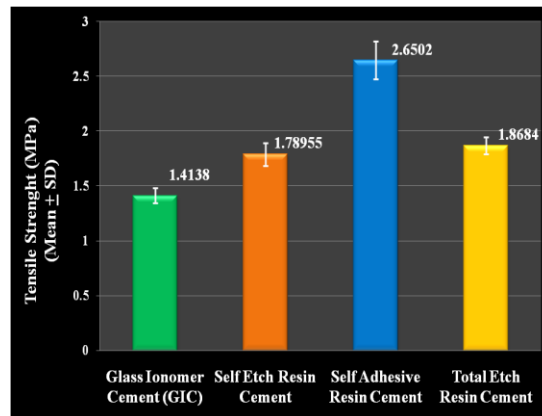


Figure 5. Mean tensile strength in MPa of pressable lithium disilicate ceramic crowns luted with different luting agents.

## RESULTS

The data thus obtained was compiled systematically, transformed from a pre-coded proforma to create a master table. The total data was distributed meaningfully and presented as individual tables (table 1 & 2) along with graphs (figure 4 & 5).

Inferential statistical analysis was carried out in the present study. Results on continuous measurements are presented on Mean  $\pm$  SD and results on categorical measurements are presented in Numbers (%). Significance is assessed at 5% level of significance. ANOVA test with post hoc Bonferroni for multiple comparison has been used to find the significance of study parameters on ordinal scale between more than two groups. Post-hoc Bonferroni test was used for multiple comparisons after the application of the ANOVA test for comparison within the groups.

The statistical software namely SPSS 19.0 was used for analysis of the data.

Table 1: Mean Failure Load of lithium disilicate ceramic crowns in Newton according to different luting agents

Group	Failure Load(N)	
	Mean	SD
Glass Ionomer Cement (GIC)	324.40	15.809
Self Etch Resin Cement	410.60	23.540
Self Adhesive Resin Cement	608.70	38.922
Total Etch Resin Cement	429.00	18.093
ANOVA (F)	430.954	
p – value	< 0.001	

Table 2: Tensile Strength of lithium disilicate ceramic crowns luted with different cementation systems.

Group	Tensile Strength	
	Mean	SD
Glass Ionomer Cement (GIC)	1.41380	0.069104
Self Etch Resin Cement	1.78955	0.102822
Self Adhesive Resin Cement	2.65020	0.172751
Total Etch Resin Cement	1.86840	0.078465
ANOVA (F)	419.974	
p – value	< 0.001	

## DISCUSSION

Dental luting agents provide a link between the restoration and prepared tooth, bonding them together through some form of surface attachment, which may be mechanical, micro-mechanical, chemical or any of this. Long term clinical success of indirect restorations is influenced by many factors, preparation design, oral hygiene, mechanical forces, and restorative materials being some of them. However, key factor to success is the choice of a proper luting agent and the cementation procedure.

In this present study, uniform circumferential chamfer margin was prepared of 1.25 mm depth. Earlier research has proved that functional stress is ultimately transferred to the marginal area and it can lead to fracture of all ceramic indirect restoration.<sup>11</sup> In some studies it appears that the marginal gaps were greater for the chamfer finish line specimens than in the shoulder finish line specimens. However, it was found that the fracture strength of the chamfer finish line samples was greater than that of the shoulder finish line samples.<sup>12</sup>

In the silica based ceramics, the glassy matrix is selectively removed by hydrofluoric acid (HF) etching, thereby increasing the surface roughness for micromechanical bonding.<sup>13</sup> Hydrofluoric acid attacks the glass phase of the ceramics, the second crystalline phase creating irregularities or surface micro-porosity within the lithium disilicate, thereby facilitating the formation of mechanical interlocking (bonding) with resin.<sup>14</sup> This procedure is generally followed by application of a silane coupling agent, which bonds with the silicone dioxide (SiO<sub>2</sub>) and copolymerizes with the organic matrix of the resin cement. In this present study the prepared samples were first etched with 5% hydrofluoric acid. It was stated that primed IPS e.max ceramic surfaces provided significantly higher retention rates than non-primed surfaces.<sup>15</sup>

During cementation a vertical seating force of 50 N was applied over the pressable lithium disilicate ceramic crowns. Seating force and choice of luting material strongly influences the resulting film thickness.<sup>16</sup> Increase in seating force is found to reduce the cement film thickness and its bond strength of the cement significantly.<sup>17</sup> It has been shown that increased seating force results in increased pulpal pressure. The delay in applying the seating force reduces the quality of cementation. It has been stated that the cementation load should not exceed 50-68 N (5 to 7 kg). The optimum cementation force required to reduce the film thickness of cement was 50 N (5 kg) for 1 minute.<sup>18</sup>

The self adhesive resin cement exhibit better adhesion due to the fact that the functional phosphoric acid methacrylates demineralizes the dentin and reacts with inorganic fillers present in the tooth substrate to create the hybrid layer. This characteristic improves the micromechanical retention.<sup>19</sup>

Another factor that helps in better adhesive property of self adhesive resin cement (SARC) is their composition; they are composed of diacrylate resins with fillers. During setting, these cements typically undergo a change in pH from acidic (pH 2.1 to 2.3) to less acidic (pH 5.6 to 6.0). The change with time to a less acidic pH may make the cement more hydrolytically stable and it may increase the mechanical interlocking to the dentin.<sup>20</sup>

Total etch systems are hydrophobic and lack moisture tolerance. The introduction of water or oral fluids at any point during the multistep bonding procedure can lead to lowered bond strengths.<sup>21</sup> In total etch resin cement, the resin tags that formed were more frequent and longer than those of self-etching resin system. The resin tags formed in both total etch resin system and two-step self-etching resin cement showed conical swelling at their base and numerous lateral branch of micro-tags that extend from the main resins tags that contribute to proper dentine infiltration.

Total-etching usually provides higher bond strength but is traditionally more technique sensitive on dentin. The major disadvantage of total etch system is post-operative sensitivity.<sup>22</sup> Etching with phosphoric acid widens the dentinal tubule openings, and these may not be completely sealed by the adhesive resin. Thus, the unsealed microporous zone could then permit the shift of hydraulic dentin fluid resulting in post-operative sensitivity. Water is necessary to maintain collagen fibril expansion in etch and rinse for resin infiltration but on contrary it plays antagonist role in hybrid layer formation.<sup>23</sup>

The answer for best luting agent with the lithium disilicate crown lies in the remaining dentin thickness of the prepared tooth structure. As it is a well known fact that total etch resin system can cause post operative sensitivity. Self etch resin cements exhibits lower incidence of post operative sensitivity. However, self etch resin cement provide lower bond strength than total etch systems because of their semi permeability, incorporation of smear layer, shorter resin tag formation, residual acidity and hydrolytic instability.

## CONCLUSION

Within the limitations of this study, following observations can be made:

- Lithium disilicate ceramic crowns luted with self adhesive resin cement showed the maximum retentive strength whereas, glass ionomer cement exhibited least retentive strength.
- Self adhesive resin cement exhibited maximum tensile bond strength followed by total etch resin cement, self etch resin cement and glass ionomer cement.
- In total etch resin cement (TE) and self adhesive resin cement (SA), fracture was found to be more common mode of failure in comparison to decementation.
- In self etch resin cement (SE) group, decementation was found to be more common mode of failure in comparison to fracture. However, glass ionomer cement (GIC) exhibited equal percentage of fracture and decementation as mode of failure with pressable lithium disilicate ceramic crowns.
- Apart from providing adequate retention, dental cement must act as a barrier against microleakage, holding the tooth and restoration together mechanically and/or chemically. The efficacy in reducing the degree of microleakage with different luting cements needs to be evaluated further.

Contributorship: All contributors on this paper meet the criteria for authorship. All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, acquisition, analysis, interpretation, writing, and revision of the manuscript.

Conflict of interest: The authors declare that there is no conflict of interest.

Funding: The author(s) received financial support for the research, authorship, and/or publication of this article.

## REFERENCES

1. Frankenberger R, Kramer N, Petschelt A. Technique sensitivity of dentin bonding: effect of application mistakes on bond strength and marginal adaptation. *Oper Dent* 2008;25(4):324-33.
2. Strub J, Rekow D, Witkowski S. Computer-aided design and fabrication of dental restorations. Current systems and future possibilities. *J Am Dent Assoc* 2006;137(1):1289-96.
3. Roesler J, Harders H, Baeker M. Mechanical behavior of engineering materials: metals, ceramics, polymers, and composites. *J Prosthet Dent* 2006;35(1):78-81.
4. Simon J, Rijk W. Dental cements. *Inside Dent* 2006;2(1):42-7.
5. Rekow E, Zhang G, Thompson V, Kim J, Coelho P, Zhang Y. Alumina based polycrystalline ceramics, a review. *Aust Dent J* 2007;14(1):25-31.
6. Shenoy A and Shenoy N. Dental ceramics: an update. *J Conserve Dent* 2010; 13(4):195-203.

7. Hill E, Lott J. A clinically focused discussion of luting agents. *Dent Mater* 2011; 34:12-7.
8. Sancakli H, Yildiz E, Isil Bayrak I, Sevda Ozel S. Effect of different adhesive strategies on the post-operative sensitivity of class I composite restorations. *Eur J Dent* 2014;8(1):15-22.
9. Kaufman G, Coelho D, Colin L. Factors influencing the retention of cemented gold castings. *J Prosthet Dent* 1961;11:487-502.
10. Hegde M, Bhandary S. An evaluation and comparison of shear bond strength of composite resin to dentin, using newer dentin bonding agents. *J Conserv Dent* 2008;11(2):71-5.
11. Beuer F, Aggstaller H, Richter, Edelhoff D, Gernet W. Influence of preparation angle on marginal and internal fit of CAD/CAM fabricated zirconia crown copings. *Quintessence Int* 2008;40:243-50.
12. Cho L, Choi J, Park C. Effect of finish line variants on marginal accuracy and fracture strength of ceramic optimized polymer/fiber-reinforced composite crowns. *J Prosthet Dent* 2004;91(6):554-60.
13. Della B. Bonding to ceramics: scientific evidences for clinical dentistry. *Dent Mater* 2006;14(1)45-51.
14. Borges U, Sophr M, Sobrhino L. Effect of etching and airborne particle abrasion on the microstructure of different dental ceramics. *J Prosthet Dent* 2003;89(2):479-88.
15. Kojic D, Singhal S, Shah S. CAD-CAM ceramic crown retention of resin cements. *J Biotechnol Biomater* 2014;4:1-7.
16. Wang C, Millstein P, Nathanson D. Effects of cement, cement space, marginal design, seating aid materials, and seating force on crown cementation. *J Prosthet Dent* 1992;67:786-90.
17. Jorgensen K. Factors affecting the film thickness of zinc phosphate cements. *Acta Odontologica Scandinavica* 1990;18:479-90.
18. Yu Z, Strutz J, Kipnis V, White S. Effect of dynamic loading methods on cement film thickness in vitro. *J Prosthodont* 1995;4:251-5.
19. Fusayama T, Nakamura M, Kurosaki N, Iwaku M. Non pressure adhesion of a new adhesive restorative resin. *J Dent Res* 1979;58(4):1364- 70.
20. Farah J, Powers M. Esthetic resin cements for all-ceramic restorations. *Dent Advis* 2005;22:11-8.
21. Bitter K, Aschendorff L, Neumann K, Blunck U, Sterzenbach G. Do chlorhexidine and ethanol improve bond strength and durability of adhesion of fiber posts inside the root canal? *Clin Oral Investig* 2014;18(3):927-34.
22. Sancakli H, Yildiz E, Isil Bayrak I, Sevda Ozel S. Effect of different adhesive strategies on the post-operative sensitivity of class I composite restorations. *Eur J Dent* 2014;8(1):15-22.
23. Gupta P, Sharma A, Pathak VK, Mankeliya S, Bhardwaj S, Dhanare P. Intricate estimation and assessment of surface conditioning of posts to improve interfacial adhesion in post-core restorations: An in vitro Study. *J Contemp Dent Pract* 2017;18(2):1-4.