ORIGINAL ARTICLE

The Effect of Cementation Techniques on Retention of Full Veneer Crowns; An In-Vitro Study

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OBJECTIVE: The objective of this current study was to identify the most effective method for cementing crowns with glass ionomer cement that would maximize retention.

METHODOLOGY: This in-vitro study was carried out by collecting 120 extracted human premolar teeth which were mounted on an acrylic block and prepared with specific total occlusal convergence and height. Metal crowns for the models were casted and cemented on the prepared premolar teeth by using three cementation techniques A) filling the crown with cement up to margins, B) applying a cement layer on all fitting surfaces and C) applying a cement layer on all fitting surfaces except occlusal surface. The force to crown dislodgment was measured and recorded in Newtons (N). Higher force was indicative of better retention. Data were analyzed using SPSS version 25. p-value less than 0.05 was considered of statistical significance.

RESULTS: The median retention load in Category C 'cementation except occlusal surface' (Median=15.04 N) was significantly higher than median retention load in Category A (Median=4.34 N) and Category B (Median=14.20 N) ($p<0.001$). Posthoc analysis showed that there was significant difference between retention of the three cementations technique A ($p<0.001$), B ($p<0.001$) and C ($p=0.022$).

CONCLUSION: There was significant difference in retention of full veneer metal crowns when three different cementation techniques were used. Retention was best when surface area was optimally maximum, cement was applied in thin layer, and cement had enough space to flow between the tooth and crown surface,. Maximizing surface area and increasing cement volume resulted in poor retention. However, applying cement in thin layer but with maximum surface area resulted in better retention.

KEYWORDS: Cementation, Cementation techniques, Crowns, Glass-ionomer cement, Retention

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INTRODUCTION

The substitution of tooth structure lost to injury or decay typically necessitates the use of a fixed dental prosthesis. Dental prostheses aid in restoring the aesthetics, function, and phonetics of one's teeth, which are crucial to daily life. The prostheses either have a tooth anchorage or are implant-retained. Crowns replace a single tooth, and bridges replace multiple teeth at once. The ideal prosthesis design would have the concept of longevity and be accurately designed in the shape and size of the tooth being replaced while protecting the tooth from the harsh oral environment. Both the patient's oral hygiene and the crown material affect how long it will last. Dental crowns can be crafted from a variety of materials, including ceramic, base metal alloys, gold alloys, and porcelain fused to metal.[1]

The selection of a suitable material establishes the foundation for the prosthesis. However, the subsequent phase encompasses retention, a crucial element for the sustained efficacy of dental restorations, particularly in the case of dental prostheses, particularly crowns.[2] Clinicians have considerable obstacles in treatment planning when choosing a crown retention approach that will yield the most favourable treatment outcome.[3] The success of fixed prostheses is contingent upon careful planning and precise execution in several stages, including tooth preparation, impression taking, prosthesis material selection, and laboratory fabrication.[4]

To achieve an overall endurance of 74.0 ± 2.1N, paying close attention to factors that affect retention is necessary. These include magnitude of dislodging forces, geometry

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of tooth preparation, taper, surface area, stress concentration, type of preparation, roughness of surfaces being cemented, type of metals being cemented, type of luting agent, cementation technique, and film thickness of luting agent.[5-6]

Furthermore, the choice of cement type plays a crucial role in effectively retaining a crown by facilitating mechanical interlocking between the two surfaces.[7] Various cement forms can be utilised as luting agents, but Glass Ionomer Cement (GIC) remains a popular option among dentists for luting permanent prostheses. GIC is considered superior in its luting properties as these materials release fluoride, chemically bond to the tooth structure, and have adequate strength in thin layers.[8] However, the physical properties of glass-ionomer cements are influenced by how the cement is prepared, including its powder: liquid ratio, the concentration of the polyacid, the particle size of the glass powder and the age of the specimens.[9]

After the luting agent, the cement's amount and location on the crown's intaglio surface are essential for crown retention. Careful placement and an adequate quantity of cement is required to avoid excess cement overflow, ultimately affecting the retentive form of the prosthesis. The success of a fixed prosthesis rests heavily on the skill with which the luting cement is applied to the surfaces it will contact.[4,10-11] Numerous studies have provided evidence of variations in the retentive capacities of prostheses when comparing diverse cementation procedures for implant-retained prostheses.[12-14]

However, information on cementation procedures for complete veneer crown implantation is scarce in the academic literature. This in-vitro study aimed to study the effect of three different cementation techniques on full veneer crown retention using GIC. The findings of this study can potentially assist dental professionals in making well-informed decisions on the selection of cementation techniques. These choices may contribute to prolonged crown retention, reduced cementation time, and cost savings by minimising luting cement loss.

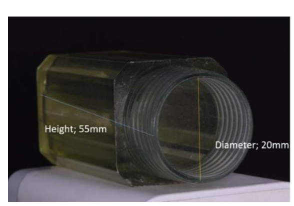
METHODOLOGY

This invitro experimental study wasconducted on 120, human premolar teeth that were visibly sound without any pathology e.g. dental caries. were obtained, stored and transported according it CDC guidelines . The extracted teeth were then mounted in an acrylic block using self-cure acrylic resin (Shofu Provinice, self-cure acrylic resin, Japan). Following complete chemical cure the teeth were prepared using a high-speed handpiece with water irrigation with diamond bur (MANI Dia-Bur-SO-11; Head Diameter: 1.2mm, Head Length: 7.7mm, 06-125µmm). The taper of the bur was constant as mentioned by the manufacturer. They were first reduced in occlusal anatomical planes and a chamfer finish line (approximately 0.75mm) was given all around. Total Occlusal Convergence was kept at 20^{o} and 25^{o} with a clinical height of 5mm. Preparation dimensions (TOC, height) of the teeth were checked using computer software (AutoCAD 2000) after taking pictures with Nikon D5300 with NIKKOR105mm lens at 100mm. The distance was reproduced using a standard metal scale which was stationary during the entire process. 2 operators were used for intra-operator reliability and the data analyzed by Dahlberg formula to confirm through correlation statistics on 15 samples. A custom-made impression tray was used to take impressions of prepared teeth with putty and light body consistency (President Original, Coltene, Germany). Models were poured using dental hard plaster (ISI-KOPO CKH-52, China). Wax-up for metal crowns with 25mm extensions (to fit the Universal Testing Machine) was done using inlay casting wax (GC-Dental Corp., Japan). Cast crowns were finished with metal discs, ensuring extensions ≥20mm. Fitting surfaces were sandblasted (MESTRA COSMOS 080233) and air-dried for cementation.

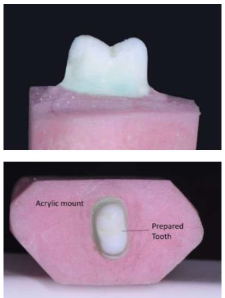
Teeth were numbered 1-120 and randomly assigned to three cementation groups using Excel by an independent operator. Forty teeth per group were allocated to an external operator, trained by the PI to apply permanent glass ionomer luting cement (3M Ketac Cem) as per manufacturer's instructions. GIC was measured using a 1cc syringe (liquid) and provided scoop (powder), mixed on a glossy paper pad. Prepared teeth and crown surfaces were gently air-dried. Crowns were cemented per assigned group using 80N pressure in a hydraulic press for 10 minutes, then stored in distilled water for 7 days. On day eight, the PI conducted blind retention testing using a Universal Testing Machine (INSTRON-4301), recording the tensile force (N) required for crown debonding. The process was supervised by a PCSIR field assistant, and equipment was calibrated prior to use.

Data were recorded using pre-formed proformas and analyzed in SPSS v25. Shapiro-Wilk test confirmed non-normal distribution; thus, medians and interquartile ranges were reported. Kruskal-Wallis test assessed group differences, with Bonferroni post-hoc applied for pairwise comparisons. Significance was set at $p \leq 0.05$.

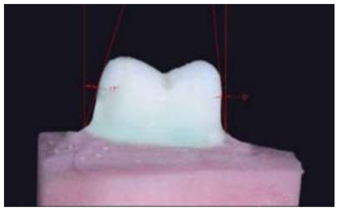
Figure 1: Step 1 to Step 5 of the process



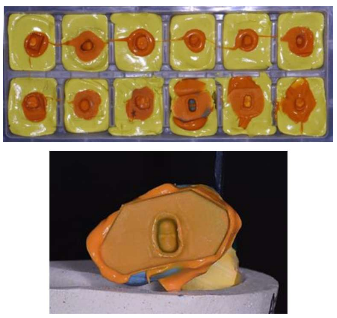
Step 1: Preformed acrylic cylinders (height; 55mm and diameter; 20mm) used to pour acrylic dough for tooth mount



Step 2: Prepared premolar tooth (Lateral view [above] and occlusal view [below])



Step 3: Total Occlusal Convergence being measured on computer software. (AutoCAD) Inter operator Reliability

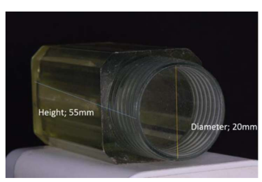


Step 4: Poured dental stone model ready for wax-up

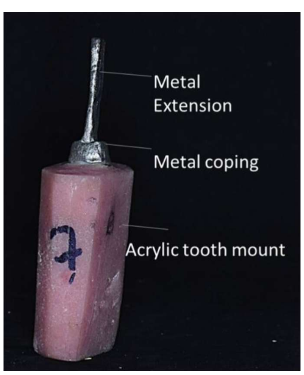
Step 5: Custom made impression tray for impression of prepared teeth with using elastomeric, addition silicone; Poly Vinyl Siloxane; putty and light body consistency (President Original, putty and light body, Coltene, Germany)

Figure 2: Step 6 to Step 9 of the process/ experiment.

Step 6: Wax-up for metal crown with metal extension (25mm) using Dental Inlay casting wax (Inlay wax medium Stick; GC-Dental Corp. Japan)



Step 7: Finished metal copings, with metal extension (23mm for this sample) in Frontal and Lateral view



Step 8: Prepared tooth in acrylic block with. cast crown. Lateral view.

Step 9: Prepared assembly mounted on the Universal Testing Machine (INSTRON-4301)

RESULTS

Data analysis was performed for 40 samples in each of the three groups. All data were non-normally distributed hence, median, and interquartile ranges are reported. Lowest median retention load of 4.35N was observed for bulk fill technique (A) whereas the highest retention load was observed for technique C (axial walls except occlusal) where median retention load was 15.04N. However, maximum retention load force was observed for technique B (all fitting surfaces,18.3N), whereas median score for this technique was 14.20N. Table 1 summarizes the descriptive results of retention load for all three categories.

Table 1: Descriptive analysis of retention load for all three categories

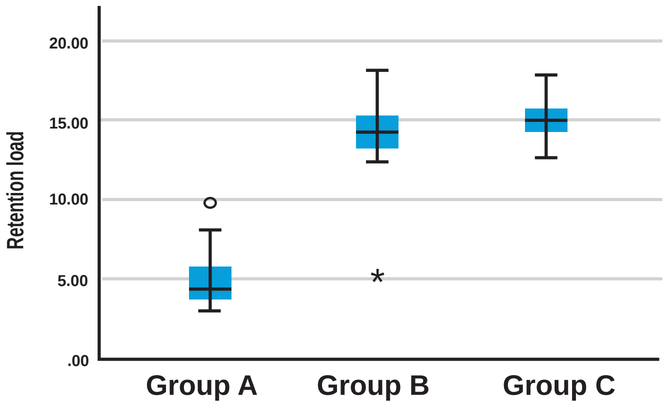
Group	Cement application technique	Median (IQR) (N)	Range(N)
A-	Bulk fill- technique	4.35 (3.66-5.73)	3.00- 9.82
B-	Thin layer on all fitting surfaces	14.20 (13.15-15.25)	5.22- 18.13
C-	Thin layer on fitting surfaces except occlusal	15.04 (14.25-15.69)	12.67- 17.78

All measurements of force are in Newtons (N)

The median retention load in category C (15.04N) was significantly higher than median retention load in category A (4.34 N) and category B (14.20 N). Comparative assessment is shown in Figure 3. Kruskal-Wallis test showed evidence that there was a difference in ranks of at least one pair of cementation methods. Hence, we were able to reject the null hypothesis, and conclude that at least one of the cementation techniques had a significantly different effect on retention of full veneer crowns ($p<0.001$).

Post-hoc Bonferroni pairwise tests were performed for the three pairs of cementation methods. There was significant difference between the cementation technique A and B ($p<0.001$). The median retention load for samples in category A was lower (4.34 N) as compared to samples in category B (14.20 N). Furthermore, there was significant difference between the samples in technique A and C ($p<0.001$). The median retention load for category A was lower (4.34 N) as compared to category C (15.04 N), and there was significant difference between the cementation technique in group B and C (p=0.022). The median retention load for group C was higher (15.04 N) as compared to cementation technique used in group B (14.20 N).

Figure 3: Comparison of median retention load between three cementation techniques, where x-axis represents categories while y-axis represents median retention load values in Newtons



DISCUSSION

Luting cements are used to fill the interfacial distance between the prepared tooth and the prosthesis being fixed. They mechanically lock the restoration in place by flowing through the microscopic contortions present between the crown and tooth surface to prevent its dislodgement during mastication. A luting agent's primary function is to fill the void at restoration-tooth interface and mechanically lock the restoration in place.[15-16] The degree of retention of a prosthesis is strongly associated with the geometry of the prepared crown/retainer (including the height, length, taper, position) and failures are associated with improper restoration fit, improper preparation geometry, cement type, cementation technique, laboratory errors, or occlusal interference during excursive movements.[17-18]

In various researches, different cementation methods such as etching, venting, die spacer application, escape channels, site of cement application and amount of cement have been assessed to improve the fixation of cast restorations. These techniques and factors have shown significant improvement in the adaption and fixation of restorations.[15] In the present study, different cementation techniques were tested to find out the best marginal adaption post-cementation with GIC. It has been found that cement applied on all surfaces except the occlusal surface gave higher retention than cement applied on all fitting surfaces and margins of the prepared tooth. Another reason for the lower retention of crowns in category C might be due to the excess amount of cement on the prepared crown margins. In another in vitro study, it was discovered that when cement was applied only on the cervical margins, lesser marginal discrepancies were observed. However greater marginal differences were discovered when cement was applied on occlusal surfaces, which may be due to the amount of cement used.[19]

The findings of our study suggest that the best technique for retention was achieved when GIC was applied on all surfaces except occlusal surface of the tooth. However, the utilization of GIC in the absence of resin sealer may also contribute to post cementation sensitivity. Selection of a luting material for optimal cementation of indirect restorations requires the consideration of several factors relating to the properties of both the cement and of the restoration. Contemporary restorations (dentine-bonded crowns or resin-retained bridges) often rely on bonding, and advances in dental materials science have resulted in simplified resin systems. Their ease of use and other favourable properties also offer advantages when used for more conventional restorations.[20] To the best of our knowledge, this study was the first to assess the effects on retention of three different cementation techniques for cementation of metal crowns. Bulk-fill technique is the most used technique of applying luting cements to crowns. Our results showed that crowns cemented with this technique resulted in dislodgment reporting low values of force to resist dislodgment. This can possibly be explained by findings from other studies that reported marginal discrepancies as a result of various cement application techniques. Bulk filling technique results in several marginal discrepancies that lower the strength of bond formed between luting agent-tooth surface and luting agent-intaglio crown surface. It also results in excessive cement at the margins which impedes proper seating of the crown up to the tooth margin These factors result in weak cementation of the dental crown to natural tooth, leading to poor retention and early dislodgment of crown.[11,13,19]

CONCLUSION

This study tested the effect of three different cement application techniques on retention of full veneer crown. Based on the results of this study and previous literature, the most suitable cement application technique is even spreading of cement on axial walls of the fitting surface of crown only (technique C). This technique resulted in maximum push-out bond strength using minimum cement, hence being cost effective. Increasing the surface area of bonding as in bulk-filling and cement application on all fitting surfaces of the crown does not result in increased bond strength. Bond strength is adversely affected in this scenario as there are increased marginal discrepancies and hydrodynamic pressure because of excess cement."

CONFLICT OF INTEREST

None to declare

REFERENCES

1. Bergeron A. The History Of Dental Crowns: From Gold To Porcelain. Adam Brown Dentistry - Monroe NC Dentist 2021. https://adambrowndds.com/the-history-of-dental-crowns-from-gold-to-porcelain/.

2. Ghodsi S, Fayyazi A, Ghiasi M, Rohanian A, Alikhasi M. Comparison of Retention and Seating of Implant-Supported Hard and Soft Metal Copings. Front. Dent. . 2020;17.
https://doi.org/10.18502/fid.v17i26.4652

[3] Vinnakota DN. Effect of preparation convergence on retention of multiple unit restorations-An in vitro study. Contemp. Clin. Dent.. 2015;6:409.
https://doi.org/10.4103/0976-237X.161904

4. Manchikalapudi G., Polasani L. R. Effect of application site of definitive cement on marginal adaptation and retention of full metal crowns: An in vitro study. Int. J. Med. Health Res., Volume 3, Issue 9, 2017, Pages 141-145.
https://doi.org/10.22271/ijmhr.2017.v3.i9.36

5. Shrivastav M. Effect of surface treatments on the retention of implant-supported cement-retained bridge with short abutments: An in vitro comparative evaluation. J. Indian Prosthodont. Soc.. 2018;18:154.
https://doi.org/10.4103/jips.jips_251_17

6. Reitemeier B, Hänsel K, Range U, Walter MH. Prospective study on metal ceramic crowns in private practice settings: 20-year results. Clin. Oral Investig.. 2019;23:1823-8.
https://doi.org/10.1007/s00784-018-2618-4

7. Xi S, Wu ZX, Gao CC, Meng YC, Pei DD, Lu Y. Influence of preparation height and cement space on the fit and retention of computer aided design/computer aided manufacturing zirconia crown. Hua Xi Kou Qiang Yi Xue Za Zhi. 2020;38:263-9.

8. Bahsi E, Sagmak S, Dayi B, Cellik O, Akkus Z. The evaluation of microleakage and fluoride release of different types of glass ionomer cements. Niger. J. Clin. Pract. 2019;22:961-70.
https://doi.org/10.4103/njcp.njcp_644_18

9. Nicholson J, Czarnecka B. Materials for the direct restoration of teeth. WP.; 2016.
https://doi.org/10.1016/B978-0-08-100491-3.00001-5

10. Chee WW, Duncan J, Afshar M, Moshaverinia A. Evaluation of the amount of excess cement around the margins of cement-retained dental implant restorations: the effect of the cement application method. J Prosthet Dent. 2013;109:216-21.
https://doi.org/10.1016/S0022-3913(13)60047-5

11. Alabdulkader MA, Habib SR. Effect of cement application techniques on the adaptation and retention of provisional crowns. Health IT. 2018;26:945-55.
https://doi.org/10.3233/THC-181351

12. Santosa RE, Martin W, Morton D. Effects of a cementing technique in addition to luting agent on the uniaxial retention force of a single-tooth implant-supported restoration: an in vitro study. Int J Oral Maxillofac Implants. 2010;25.

13. Wadhwani C, Hess T, Piñeyro A, Opler R, Chung KH. Cement application techniques in luting implant-supported crowns: a quantitative and qualitative survey. Int J Oral Maxillofac Implants. 2012;27.

14. Safari S, Hosseini Ghavam F, Amini P, Yaghmaei K. Effects of abutment diameter, luting agent type, and re-cementation on the retention of implant-supported CAD/CAM metal copings over short abutments. J Adv Prosthodont.. 2018;10:1-7.
https://doi.org/10.4047/jap.2018.10.1.1

15. Habib SR, Ali M, Al Hossan A, Majeed-Saidan A, Al Qahtani M. Effect of cementation, cement type and vent holes on fit of zirconia copings. Saudi Dent. J.. 2019;31:45-51.
https://doi.org/10.1016/j.sdentj.2018.09.001

16. Lad PP, Kamath M, Tarale K, Kusugal PB. Practical clinical considerations of luting cements: A review. JIOH. 2014;6:116.

17. Gowd MS, Shankar T, Ranjan R, Singh A. Prosthetic consideration in implant-supported prosthesis: A review of literature. JISPCD. 2017;7(Suppl 1):S1.
https://doi.org/10.4103/jispcd.JISPCD_149_17

18. Sambandam TV, Ganapathy D. Retentive properties of luting cements with implant abutments: A systematic reviewDIT. 2020 Apr 15;14.

19. Cardoso M, Torres MF, Rego MR, Santiago LC. Influence of application site of provisional cement on the marginal adaptation of provisional crowns. J. Appl. Oral Sci.2008;16:214-8.
https://doi.org/10.1590/S1678-77572008000300010

20. Rickman LJ, Satterthwaite JD. Considerations for the selection of a luting cement. Dent. Update.. 2010;37:247-64.
https://doi.org/10.12968/denu.2010.37.4.247i