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Comparative evaluation of the retention of provisional crowns luted with two different cements and cementation techniques – An in vitro study.

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Abstract

Background and Objectives: The importance of provisional restoration is often neglected because they do not usually have to last long. But in patients requiring adjunctive treatments, provisional restoration and a luting cement with good retentive properties that can withstand washout, marginal leakage, penetration of bacteria and caries is needed. Failures in fixed prosthodontics are more due to improper retention form, selection of inappropriate temporary cement and cementing method. There is no study that has comparatively evaluated the retention of provisional crowns in regards to cementation techniques and temporary cements. The present study will help a clinician to choose an appropriate temporary luting cement and cementation technique for maximum retention in provisional crowns.

Aims and Objectives: To compare and evaluate the retention of provisional crowns luted with two different cementation techniques and temporary cements.

Method: Forty human extracted mandibular molar teeth were prepared following the principles of tooth preparation. Provisional crowns were using Bis-acryl composite temporization material. The samples were divided into 4 groups (n=0) based on cementation techniques and Zinc Oxide Eugenol and Non-Eugenol cements. The provisional crowns were cemented and subjected to tensile forces using universal testing machine and retentive strengths of the specimen were measured in Newton.

Results: Mean tensile bond strength in Newton and standard deviation values were 7.9620 N (1.86671) in Group A, 18.9770 N (7.76064) in Group B, 9.5280 N (2.37128) in Group C and 19.6230 N (7.24433) in Group D respectively. The highest values to lowest being Group D, Group B, Group C and Group A.

Interpretation and Conclusion: Within the limitations of the study, it can be concluded that the retention of the provisional crowns is higher when cemented by applying the cement on the cervical one third of the intaglio surface of the crown irrespective of the temporary cement used.

Keywords: Axial wall Cementation technique, Cervical third cementation technique, Provisional crown, Zinc Oxide Eugenol, Zinc Oxide Non-Eugenol.

Introduction

A provisional or temporary restoration aids in preserving pulpal and periodontal health, encouraging control-led tissue healing to achieve an appropriate emergence profile, preventing abutment migration, providing an adequate occlusal scheme and maintaining a good maxilla- mandibular relationship.1 The importance of provisional restoration is often neglected because they do not usually have to last long. But in patients requiring adjunctive treatments, provisional restoration operates for an extended amount of time than the normal. These cases require a provisional restoration and a luting cement with good retentive properties that can withstand washout, marginal leakage, penetration of bacteria and caries.[2]

A good retentive provisional crown helps to produce better final restoration and saves a lot of time and money at subsequent appointments. The time spent in their fabrication would, in turn, be more than compensated in time saved later by additional procedures, changes, and remakes.[1] Failures in fixed prosthodontics are more due to improper retention form, selection of inadequate temporary cement and cementing method which lead to problems such as micro-leakage, soft tissue swelling, early loss and eventually tooth migration.[3]

The literature available regarding the retentive strength of zinc oxide eugenol and non- eugenol cements is less and reports contradictory findings.[4,5] A study evaluated the effect of cementation techniques on retention of provisional crowns.[3] There is no study that has comparatively evaluated the retention of provisional crowns in regards to cementation techniques and temporary cements. Hence, the present study was conducted to comparatively evaluate the retention of provisional crowns luted with two different cementation techniques using Zinc Oxide Eugenol and Non-Eugenol cements. Thereby helping a clinician to choose an appropriate temporary luting cement and cementation technique for maximum retention in provisional crowns.

Methods

This prospective, in vitro study was conducted in the Department of Prosthodontics, Bapuji Dental College and Hospital, Davangere, Department of Prosthodontics, Maratha Mandal Dental College, Belagavi, and Department of Mechanical engineering, Gowdara Mallikarjun Appa Institute of Technology, Davangere.

Fabrication of test specimen [3] (fig 1)

Forty human extracted mandibular molar teeth were mounted on 15x15mm square-shaped acrylic resin blocks. Putty indexes of the same were made using polyvinyl siloxane putty material (GC FL exceed). The molar teeth were then mounted on the clamp of the milling device (AF350 – Amann Girrbach AG) to standardize the preparation. Axial reduction of 1-1.5mm was done using milling burs and a finish line and optimum taper were obtained. The occlusal reduction of 1.5-2mm was done using the putty index as reference

and tooth preparation burs (crown and bridge preparation kit, Shofu Inc.) and Airo tar hand piece (NSK Pana Air C6552727, Japan).

Preparation of provisional crowns [3] (fig 2,3)

Provisional crowns were fabricated following the manufacturer's instructions using Bis-acryl composite temporization material (Protemp TM, 3M ESPE).The material was dispensed into the putty indexes using auto-mixing tips and a dispensing gun (Denmax).The provisional crowns were retrieved after the First Author's name, et al. International Journal of Dental Sciences and Innovative Research (IJDSIR) © 2017 IJDSIR, All Rights Reserved Page 3 completion of polymerization and checked for any irregularities. The provisional crowns were then trimmed and finished using acrylic burs and the fit was assessed by visual inspection. A resin block of 10x10mm was fabricated over the occlusal aspect of provisional crowns to aid in the placement of hook of the universal testing machine. The models were divided into 4 groups with each group having 10 samples based on cementation techniques and Zinc Oxide Eugenol and Non-Eugenol cements. Group AProvisional crowns luted with Zinc Oxide Eugenol cement and axial wall cementation technique, Group B-Provisional crowns luted with Zinc Oxide Eugenol cement and cervical one-third cementation technique, Group C- Provisional crowns luted with Zinc Oxide Non-Eugenol cement and axial wall cementation technique, and Group D- Provisional crowns luted with Zinc Oxide Non- Eugenol cement and cervical one-third cementation technique. The temporary cements were dispensed, mixed and applied accordingly using micro-applicator tips. The provisional crowns were cemented onto the respective prepared molar teeth under finger pressure. The specimens were kept in distilled water for 24 hours at room temperature. An acrylic block was fabricated over the occlusal aspect of the provisional crown to facilitate attachment to the UTM.

Grouping of the finished samples [3] (figure 4)

The models were divided into 4 groups with each group having 10 samples based on cementation techniques and Zinc Oxide Eugenol and Non-Eugenol cements. Group A-Provisional crowns luted with Zinc Oxide Eugenol cement and axial wall cementation technique, Group B-Provisional crowns luted with Zinc Oxide Eugenol cement and cervical one-third cementation technique, Group C- Provisional crowns luted with Zinc Oxide Non-Eugenol cement and axial wall cementation technique, and Group D- Provisional crowns luted with Zinc Oxide Non- Eugenol cement and cervical one third cementation technique.

Measurement of tensile bond strength in universal testing machine [3] (figure 5)

The specimens were mounted onto the custom-made fixtures which were attached to the universal testing machine and subjected to tensile forces of 500Kn at a crosshead speed of 1.0 mm per minute and force at which the crown dislodges was considered as the retentive strength of the provisional crown. The tensile bond strength values were measured in mega pascals (MPa).

Results

The present study was aimed to compare and evaluate the retention of provisional crowns luted with two different temporary cements and cementation techniques. The values of the tensile bond strength (Newton) of the samples of all four groups were tabulated. The data was gathered and entered in MS Excel spreadsheet. Data was analyzed using SPSS version 26. Data analysis was carried out using Descriptive statistics and other relevant tests of significance. The p value was set at 0.05 to be

significant, and p value less than 0.01 was considered as highly significant. Confidence level was set at 95% and power of the study was fixed at 80%.

Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide Eugenol cement by using axial wall and cervical one-third cementation techniques was computed using independent t test (unpaired t test). The associated p value and the number, mean +- Standard deviation, with respect to the variables were also displayed by the test.

Table I shows that statistically there is a highly significant P<0.05 difference in Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide Eugenol cement by using axial wall (Group A) and cervical (Group B) one-third cementation techniques. The retention seen in group B is significantly higher than that of group A, which can be seen from the mean values as given in the table.

Graph 1 shows Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide Eugenol cement by using axial wall (Group A) and cervical (Group B) one-third cementation techniques.

Graph 1 shows Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide Eugenol cement by using axial wall (Group A) and cervical (Group B) one-third cementation techniques.

Table II shows that statistically there is a highly significant P<0.05 difference in Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide Non - Eugenol cement by using axial wall (Group C) and cervical (Group D) one-third cementation techniques. The retention seen in group D is significantly higher than that of group C, which can be seen from the mean values as given in the table.

Graph 2 shows Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide NonEugenol cement by using axial wall (Group C) and cervical (Group D) one-third cementation techniques.

Similarly, Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol and Zinc Oxide Non-eugenol cements using Axial Wall cementation technique was computed using independent t test (unpaired t test). The associated p value and the number, mean +- Standard deviation, with respect to the variables were also displayed by the test.

Table III shows that statistically there is no significant P>0.05 difference in Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol (Group A) and Zinc Oxide Non-eugenol cements (Group C) using Axial Wall cementation technique. However, the retention seen in group C is higher than that of group A, which can be seen from the mean values as given in the table.

Graph 3 shows Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol and Zinc Oxide Non-eugenol cements using Axial Wall cementation technique.

Similarly, Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol and Zinc Oxide Non-eugenol cements using Cervical third Wall cementation technique was computed using independent t test (unpaired t test). The associated p value and the number, mean +- Standard deviation, with respect to the variables were also displayed by the test.

Table IV shows that statistically there is no significant P>0.05 difference in Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol (Group B) and Zinc Oxide Non-eugenol cements (Group D) using Cervial Wall cementation

technique. However, the retention seen in group D is higher than that of group B, which can be seen form the mean values as given in the table. Graph 4 shows Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol and Zinc Oxide Non-eugenol cements using cervical Wall cementation technique.

Discussion Various cementation protocols are practiced, with no optimal technique/combination that maximizes crown seating and marginal fit. The incomplete seating of crowns resulting from faulty cementation technique is a universal problem for dental clinicians. The improper seating of crowns is mainly due to the entrapment of luting cement between the fitting surface of the crown and the tooth. This results in increased hydrodynamic pressure between the crown and the tooth during cementation, thus preventing complete seating of the crown and thereby decreasing the retention of the provisional crown. [1,3,28,29,31]

Ahmed Alabdulkader and Syed Habibb conducted a study to evaluate the effect of cement application technique on the adaptation and retention of provisional crowns. They reported that cement application on axial walls and cervical third of intaglio surface of the provisional crowns may be considered as method of choice with regards to adaptation and retention.[3]

Manchikalapudi and Pola Sani, in their study assessed the variation in the cement application techniques on both marginal discrepancy and retention of provisional crowns. They proposed that luting cement applied along a smaller area of the internal surface, towards the margins, facilitates escape of excess cement and better seating of crowns. On the other hand cement applied all along the internal surface including the occlusal surface leads to improper seating of full crown due to inability of excess cement to escape. Also reported that decrease in the amount and area of application of the luting agent significantly decreases the marginal discrepancy of a cemented full crown. However, subsequent decrease in bonding area of the luting agent also significantly reduces the retention of the full crown.[2]

Mayra Cardoso, Marcelo Ferreira Torres, Mariana Ribeiro De Morae's Rego and Luiz Carlos Santiago suggested that better marginal fit was achieved after cementation of provisional crown restorations when the cement was applied to the cervical margin of the prepared tooth, to the cervical crown margin or to the internal surfaces of the provisional crown, except for the occlusal surface.[15]

Paul Olin, Joel Rudney and Elaine Hill reported that the non-eugenol cements had higher retention values than the eugenol-containing cements whereas Xavier Lepe, David Bales and Glen Johnson reported that the retention values of provisional crowns luted with eugenol and non-eugenol cements showed no difference but the mean values of the eugenol cement were greater than the non-eugenol cement.[10,4]

Several types of resins can be used for making custom provisional restorations. They include Poly methy Methacrylate, Polyvinyl ethyl Methacrylate, Bis-acryl composite resin and Urethane Dimethacrylate.30 Bhavya Amin, Meena Aras, Vidya Chitre reported that the Bis-acryl composite crowns showed significantly less marginal discrepancy than the when compared to Polymethyl Methacrylate crowns.[21]

Manju Choudhary that 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. Zinc oxide eugenol cement in comparison to non-eugenol cement affects the transverse

strength of provisional restorative materials significantly.[25]

The data in the present study revealed significant differences in the retention values of provisional crowns luted using cervical third and axial wall cementation techniques whereas the intergroup comparison between the eugenol and non-eugenol cement was statistically insignificant.

The extracted molars in the study were mounted and prepared using a milling apparatus following the principles of tooth preparation. Sajjan Chandra Shekar, Kamath Girdhar and K. Suhas Rao reported that 30–6 0 taper (or 60–120 total occlusal convergence) has shown to be ideal for maximum retention clinically as 00 taper is difficult to obtain clinically.17 Omar Zidane and Gary C. Ferguson reported that increasing the taper of the preparation from 6 degrees to 12 degrees did not affect the retention of crowns within the different cement groups. The choice of cement for crowns prepared within this ideal range of taper might be of limited clinical significance but increasing the taper to 24 degrees decreased the retention of crowns significantly.[14] Ahmed Alabdulkader and Syed Habibb, in their study, cemented the provisional crowns with six cement application techniques using a micro brush or a micro applicator tip.3 Mayra Cardoso, Marcelo Ferreira Torres, Mariana Ribeiro De Morae's Rego and Luiz Carlos Santiago suggested in their study the use of a brush for cementing provisional crowns.15 In the present study, the cementation of the provisional crowns was done using a micro applicator tip.

Tensile strength is the ability of a material to withstand a pulling force and refers to the breaking strength of the material. The forces acting on a tooth while mastication includes tensile, compressive and shear forces. Hence the retention of the provisional crowns to withstand the masticatory forces is important to prevent it from dislodgement. The tensile strength of a specimen is checked using a universal testing machine. In the present study as well the retention of the provisional crowns was evaluated using the universal testing machine. A square shaped resin block was fabricated over the occlusal surface of the provisional crown in the present study to facilitate the attachment of hook in universal testing machine for recording of the retention (Tensile strength) of the samples in accordance with the study by Ahmed Alabdulkader and Syed Habibb. [3]

Mayra Cardoso, Marcelo Ferreira Torres, Mariana Ribeiro De Morae's Rego and Luiz Carlos Santiago reported that there was no significant difference statistically regarding the marginal discrepancy of the provisional crowns cemented with ZONE cement applied on the cervical margin, axial wall and tooth margin. But the mean values recorded showed that the CA group (67.2 µm) showed more discrepancy then the CM group (45.9 µm). Similarly Ahmed Alabdulkader and Syed Habibb reported that there was no significant difference between the retention values for provisional crowns cemented using axial and cervical third application. But the mean showed a difference with axial wall group (0.3734 Mpa) and cervical third group (0.4510 Mpa).15 In the present study contradictory results were achieved, the retention values for the cervical third technique and axial wall technique were statistically different. The cervical third technique showed a mean retentive strength First Author's name, et al. International Journal of Dental Sciences and Innovative Research (IJDSIR) © 2017 IJDSIR, All Rights Reserved Page 7 (18.9770 N) using ZOE cement and (19.6230 N) using ZONE cement when compared to the axial wall technique which recorded (7.9620 N) using ZOE cement and (9.5280 N) using ZONE cement.

David Asif, Shimon Azoulay and Colin Gorfil, reported that the spread of cement under the crown when luted only on the crown margins is seen axially and slightly occlusally whereas when luted using axial walls shows spread of cement occlusally. In the present study similar spread of cement was observed. He reported that that there is a direct relationship between retention and the surface area of cement coverage but one should not forget the role of hydrodynamic pressure.[11] This is in accordance with Alabdulkader and Syed Habibb who proposed that adaptation discrepancies are more when luting cement is applied on the occlusal surface of the crowns.[3] The reason the group with axial wall cementation technique luted with ZOE and ZONE cements showed lesser mean retentive values can be attributed to the spread of the cement occlusally and the role hydro dynamic pressure preventing proper adaptation of provisional crown and thereby affecting the retention.

In the present study, there was no significant difference between the retention values of provisional crowns cemented with ZOE and ZONE cements irrespective of the cementation technique used. This is in accordance to David Bales and Glen Johnson who reported that the retention values of provisional crowns luted with eugenol and non-eugenol cements showed no difference.

Hence within the limitations of the study, it can be concluded that the retention of the provisional crowns is higher when cemented by applying the cement on the cervical one third of the intaglio surface of the crown irrespective of the temporary cement used. Though one should keep in mind the cementation technique alone doesn't influence the retention but retention is affected by the nature of the tooth preparation and the angulation of the walls, the retentive surface area-wall height, preparation circumference, and the nature of the surface (smooth or rough) and the cement material and the area of cement affected by forces. Further studies are required to compare the above-mentioned parameters.

Because of the in vitro methodology of the study and the lack of an oral environment, the results of the current study should be interpreted with care. The physical qualities of the temporary cements may be hampered by the lack of saliva, lack of temperature change found intraorally, and the absence of food inside the mouth. The results obtained could vary if the bond strengths were tested inside the oral cavity i.e., under natural conditions where presence of saliva. Another potential constraint is human error in the sample production, cementation, and measurement processes. Despite the fact that an attempt was made to solve all of these flaws.

Conclusion

Within the limitations of this study, There is significant increase of mean tensile retentive strength of provisional crowns luted with zinc oxide eugenol or zinc oxide non-eugenol cement using cervical third cementation technique when compared to the axial wall cementation technique.

Clinical implication

It can be concluded that the retention of the provisional crowns is higher when cemented by applying the cement on the cervical one third of the intaglio surface of the crown irrespective of the temporary cement used. Though one should keep in mind the cementation technique alone doesn't influence the retention but retention is affected by the First Author's name, et al. International Journal of Dental Sciences and Innovative Research (IJDSIR) © 2017 IJDSIR, All Rights Reserved Page 8 nature of the tooth preparation and the angulation of the walls, the retentive surface area-wall height, preparation circumference, and the nature of the surface

(smooth or rough) and the cement material and the area of cement affected by forces.

Photographs

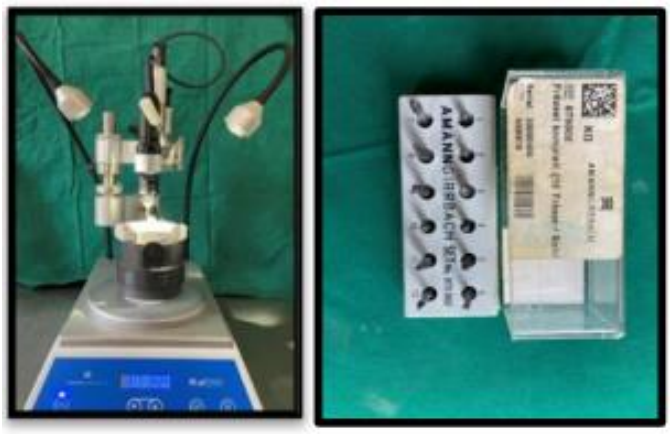


Fig 1: tooth preparation of the mounted extracted mandibular molar tooth on the milling apparatus.

Fig 2: mixed zinc oxide non- eugenol cement and zinc oxide eugenol cement applied onto the internal surface of the provisional crown & cervical one-third of the intaglio surface of the provisional crown using a micro applicator tip.

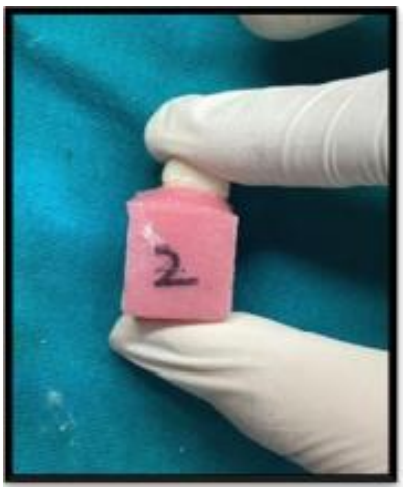


Fig 3: provisional crown cemented onto the prepared tooth under firm finger pressure.

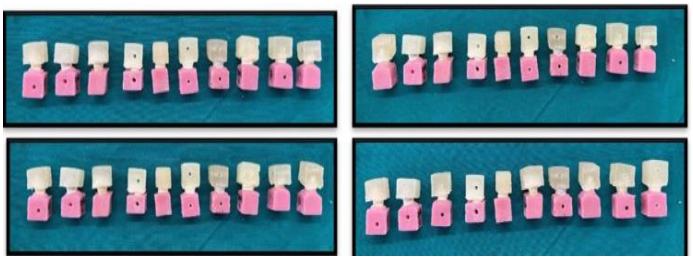
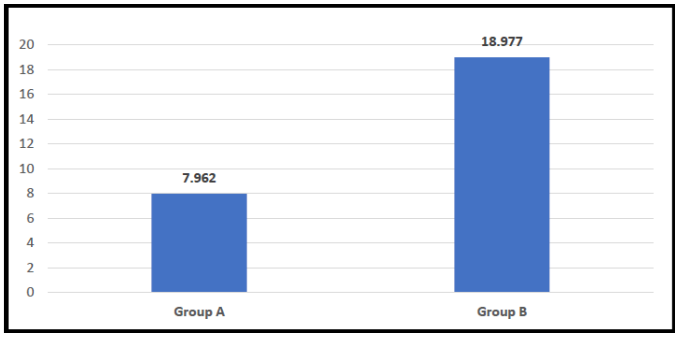


Fig 4: Group A (n=10) provisional crowns cemented using zinc oxide eugenol cement and axial wall cementation technique. Group B (n=10) provisional crowns cemented using zinc oxide eugenol cement and cervical one third wall cementation technique. Group C (n=10) provisional crowns cemented using zinc oxide noneugenol cement and axial wall cementation technique. Group D (n=10) provisional crowns cemented using zinc oxide non-eugenol cement and cervical one third wall cementation technique.

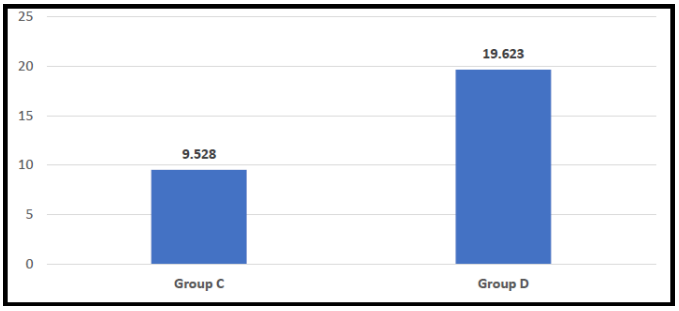
Fig 8: the specimen mounted on the universal testing machine (tec-sol India)

Graphs

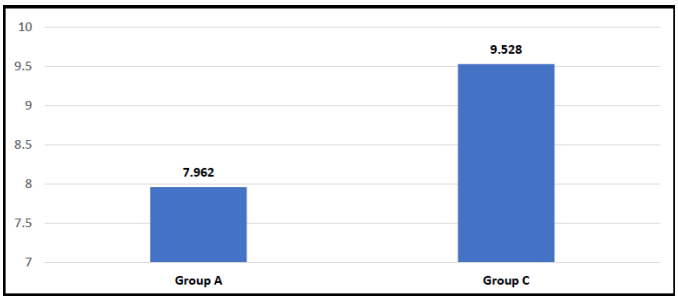
Graph 1: Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide Eugenol cement by using axial wall (Group A) and cervical (Group B) one-third cementation techniques.



Graph 2: Intergroup comparison of the amount of retention (N) of provisional crowns luted with Zinc Oxide NonEugenol cement by using axial wall (Group C) and cervical (Group D) one-third cementation techniques.



Graph 3: Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol and Zinc Oxide Noneugenol cements using Axial Wall cementation technique.



Graph 4: Intergroup comparison of the retention of provisional crowns luted with Zinc Oxide Eugenol and Zinc Oxide Non-eugenol cements using cervical Wall cementation technique.

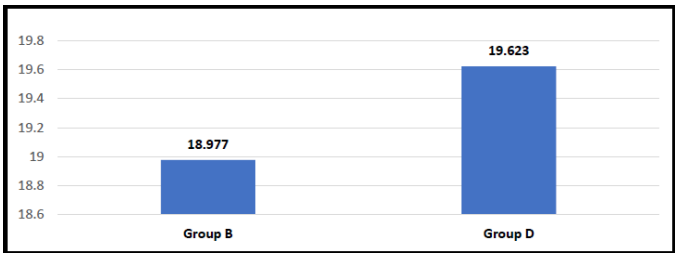


Table 1: Intergroup Comparison Of The Amount Of Retention (Newton) Of Provisional Crowns Luted With Zinc Oxide Eugenol Cement By Using Axial Wall (Group A) And Cervical (Group B) One-Third Cementation Techniques.

Groups	Number	Mean	Std. Deviation	t value	p value
Group A	10	7.9620	1.86671	-4.36	0.000**
Group B	10	18.9770	7.76064		

*p<0.05 is statistically significant, p<0.05 is statistically highly significant

Table 2: Intergroup Comparison of the Amount of Retention (Newton) Of Provisional Crowns Luted with Zinc Oxide Non- Eugenol Cement By Using Axial Wall (Group C) And Cervical (Group D) One-Third Cementation techniques.

Groups	Number	Mean	Std. Deviation	t value	p value
Group C	10	9.5280	2.37128	-4.188	0.001**
Group D	10	19.6230	7.24433		

*p<0.05 is statistically significant, p<0.05 is statistically highly significant

Table 3: Intergroup Comparison of The Retention Of Provisional Crowns Luted With Zinc Oxide Eugenol And Zinc Oxide Non-Eugenol Cements Using Axial Wall Cementation Technique.

Groups	Number	Mean	Std. Deviation	t value	p value
Group A	10	7.9620	1.86671	-1.64	0.118
Group C	10	9.5280	2.37128		

*p<0.05 is statistically significant, p<0.05 is statistically highly significant,

Table 4: Intergroup Comparison of The Retention of Provisional Crowns Luted with Zinc Oxide Eugenol and Zinc Oxide Non-Eugenol Cements Using Cervical Wall Cementation Technique.

Groups	Number	Mean	Std. Deviation	t value	p value
Group B	10	18.9770	7.76064	-0.192	0.850
Group D	10	19.6230	7.24433		

*p<0.05 is statistically significant, p<0.05 is statistically highly significant,

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