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RESEARCH ARTICLE

EVALUATION OF STAINLESS-STEEL CROWN CEMENTED WITH GLASS IONOMER CEMENT, RESIN MODIFIED GLASS IONOMER CEMENT AND NEW SELF-ADHESIVE RESIN CEMENT: AN INVITRO STUDY

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Abstract

Aim: To assess and compare the retentive strength of stainless-steel crown cemented with glass ionomer cement (GC Fuji I), resin modiifed glass ionomer cement (Relyx Luting 2) and new self-adhesive resin cement (RelyX U200).

Materials and Method: Forty-five extracted primary teeth were mounted on acrylic blocks. Stainless steel crowns were selected for each tooth. Three cements compared in this in vitro study were glass ionomer cement (GC Fuji I), resin modified glass ionomer cement (RelyX Luting2) and self-adhesive resin cement (RelyX U200). Teeth were randomly divided into three groups of 15 samples each. Retentive strength was tested using Instron Universal testing machine. The retentive strength values were recorded and calculated by the formula: Load/Area.

Results: RelyX U200 (Self-adhesive resin cement) showed significantly higher retentive strength than rest of the two cements. No significant difference was found between RelyX Luting 2 (Resin modified glass ionomer cement) and GC Fuji I (Glass ionomer cement).

Conclusion: The finding of our study suggests that self-adhesive resin cement was better than resin modified glass ionomer cement and glass ionomer cement. RelyX U200 (Self-adhesive resin cement) can be used for the cementation of stainless-steel crowns.

Introduction:-

Humphrey developed and introduced stainless steel crowns (SSCs) in 1950 as temporary coverage for primary teeth in children.[1] These crowns have proved to be very economical and durable with several clear-cut indications for use in primary teeth including: following a pulpotomy/pulpectomy; for teeth with developmental defects or large carious lesions involving multiple surfaces where an amalgam is likely to fail; and for fractured teeth.[2] They are widely accepted and play a significant part in the restorative armamentarium in pediatric dentistry. The retentive feature of stainless-steel crown depends on the close adaptation of crown margin to the tooth surface in undercut area and utilization of suitable luting cement which fills the gap between tooth structure and crown.[3]

Luting cements are dental cements used to attach indirect restoration to the prepared tooth. Its primary function is to fill the void at restoration-tooth interface and mechanically lock the restoration in place to prevent its dislodgement during mastication.[4] Depending on the expected longevity of the restoration, a luting agent may be definitive (long term) or provisional (short-term).[5] Earlier, there was only one luting agent available i.e., zinc phosphate cement.

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Currently, a plethora of luting agents are available.[6] With the development of material technology, dental cements have evolved into stronger and more durable materials.[7] Glass ionomer cement is more popular and used worldwide as a luting cement. It is primarily indicated for luting metal and metal-ceramic restoration although it can be used with high strength core (alumina or zirconium) all-ceramic crowns. Resin-modified glass ionomer cement (RMGIC) is a hybrid formulation of resin and glass ionomer components. They are available as dual- or tri-cured materials. Self-adhesive resin cements a new subgroup of resin cements, do not require any pre-treatment of the tooth surface. Once the cement is mixed, its application is accomplished in a single clinical step.[8] They are cured by light polymerization, and they contain glass particles that are chelated to release fluoride.

The present in vitro study is thereby undertaken for evaluation of retentive strength of stainless-steel crowns cemented with glass ionomer cement, resin modified glass ionomer cement and dual polymerized self-adhesive resin cement.

Materials and Method:-

45 primary extracted teeth were mounted on cold cure acrylic resin blocks exposing the crown till the cementoenamel junction. Then appropriate crown was selected by a trial-and-error procedure with respect to the mesiodistal width and cervico-occlusal height of each tooth. Pretrimmed, precontoured SSCs were selected. Conventional tooth preparation for SSCs were performed by a single operator. The occlusal surfaces of all the teeth were reduced uniformly by using a straight fissure bur (#56). This was established by placing depth orientation grooves at the cuspal heights. The proximal surfaces were prepared with a tapered fissure bur (#848L) by removing all mesial and distal undercuts without leaving any ledges. All sharp line angles were rounded. For each prepared tooth, a prefabricated SSC was selected, fitted, contoured, and crimped with contouring and crimping pliers. The crown was removed, and 19-gauge wire hook was soldered on occlusal surface of all crowns to facilitate an attachment for the universal testing machine. Specimens were divided into three groups:
Group I: GC Fuji I (Glass ionomer cement)
Group II: RelyX luting 2 (Resin modified glass ionomer cement)
Group III: RelyX U200 (Self-adhesive resin cement)

All teeth were cleaned with pumice and water before cementation. All cement were used according to the manufacturer's instructions at room temperature. They were then loaded into the crown and each crown was seated with finger pressure. After the initial set, excess cement was removed from the crown tooth interface using an explorer. The teeth were stored in artificial saliva and incubated at 37° C for 24 hours.

Artificial saliva was prepared by mixing 0.220 gm of calcium chloride, 1.07 gm of sodium phosphate, 1.68 gm of sodium bicarbonate, and 2 gm of sodium azide and then adding 1L of distilled water. PH of saliva was adjusted to 7 to 7.09 using pH meter. Retentive strength was tested using instron universal machine (fig 1). The machine was fitted with an instron recorder. After stabilization of the specimen on the machine (fig 2), load was applied which gradually increased from zero reading to a point until the cemented crowns showed dislodgement and the corresponding value was noted from the testing machine computer monitor. The same procedure was followed for all the specimens. The applied load was directly parallel to the long axis of the tooth during crown removal with a cross head speed of machine 0.05"/ minute. The retentive strength values were recorded, expressed in terms of kgF/cm^2 which was calculated by the formula: Retentive strength = load/ area.

The surface of the crown was determined by cut opening the crowns and their surfaces were developed on graph sheet and the areas of these developed surfaces were determined by counting the squares on the developed areas.

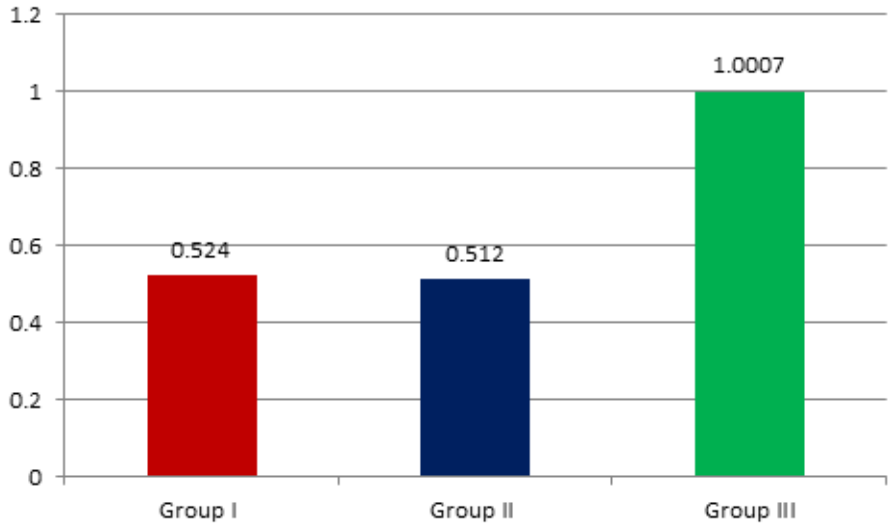
Results:-

Statistically significant difference was found between the groups. Highest retentive strength was seen in RelyX U200 (Self-adhesive resin cement) followed GC Fuji I (Glass ionomer cement) and RelyX Luting2 (Resin modified glass ionomer cement).(table 1, graph 1)
Group I: GC Fuji I group: mean retentive strength was 0.53 while highest was 1.00 and lowest was 0.16
Group II: RelyX luting 2 group: mean retentive strength was 0.51 while highest was 2.00 and lowest was 0.20
Group III: RelyX U200: mean retentive strength was 1.00 while highest was 1.42 and lowest was 0.36

	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Group I (GIC)	0.5240	.36087	.09318	.16	1.00

Group II (RMGIC)	0.5120	.69639	.17981	.20	2.70
Group III (Dual polymerizing Self-adhesive resin cement	1.0007	.24613	.08355	.36	1.42

Table 1:- Mean retentive strength of luting cements.



Graph 1:- Mean retentive strength.

Discussion:-

The restoration of severely broken-down primary molars is often a clinical challenge.[9] This is due to factors such as patient non-cooperation, primary tooth morphology, differences in tooth structure, and the type of restorative material used. This challenge can be overcome by use of stainless-steel crowns as they provide full coronal coverage and are easily placed with minimal technique sensitivity. According to the American Academy of Pediatric Dentistry (AAPD) stainless-steel crowns (SSC's) should be used where caries involves multiple surfaces of primary teeth.[10]

Studies compared the retention of stainless-steel crowns with and without cementation (i.e., mechanical retention from the crown alone and retention due to cementation) and it was found that retention due to cementation to be far greater than that gained from mechanical retention alone. This clearly shows that the placement of cement is necessary for the placement of stainless-steel crowns.[11]

Primary molars were selected in our study because stainless steel crowns are more widely used on primary molars following pulp therapy, in deciduous teeth with developmental defects, multisurface caries, teeth with extensive wear and as an abutment for space maintainer. They are often the first choice for the repair of defects in primary dentition but because of their non-esthetic appearance they are usually not preferred for anterior teeth.

All the samples were stored in artificial saliva for twenty-four hours prior to retentive strength testing to reproduce the acidic environment of the oral cavity. 19-gauge wire hook was soldered on occlusal surface of all crowns to facilitate an attachment for the universal testing machine, to disseminate force during force application and to avoid focused force and crown deformity. **Yilmaz et al[12]** and **Parisay I et al[13]** used the same procedure as ours for crown removal test; however, 19-gauge wire hook was not used in their study.

Conventional Glass Ionomer Cement are more commonly used luting agent. Their physical strengths are sufficient for cementing stainless steel crowns, space maintainers, and individual stainless steel orthodontic bands with an added benefit of fluoride release, but they have low fracture toughness, limiting its applications in high load-bearing areas, low flexural strength and wear resistance.[14] Study like **Reddy MH et al[15]** have shown better retentive strength of glass ionomer for luting of stainless-steel crown.

Resin modified glass ionomer cement was introduced with enhanced toughness and reducing dissolution of conventional GIC. Glass polyalkonate present in glass ionomer cement was replaced with water –hydromethyl methacrylate mixture. It is a dual-cure hybrid, because setting happens by a combination of the long-term, complex acid-base reaction like glass-ionomer cement and chemical or light initiated polymerization of the added resin. [16] but they require the use of intermediary agents or primers to achieve effective bonding.[17]

Fig 1:- Universal instron testing machine.

Fig 2:- Testing of specimens.

Self-adhesive resin cement was developed as an alternative to the traditional cementation options of conventional resin cement and RMGI cements. It combines technologies from glass ionomer materials, adhesives and composite cement to create a universal cement appropriate for inlays, onlays, crowns, bridges, posts, pins and screws made of ceramics, composite or metals[18]. It includes the application of the adhesive and cement at the same time so it can bond to an untreated tooth surface that has not been micro-abraded or pretreated with an etchant, primer, or bonding agent; thus, cementation is accomplished in a single step.[19]

According to results of our study Dual polymerizing Self-adhesive resin cement proved to be best in explanation to the above it contains new dimethacrylate monomer and innovative technology for initiating polymerization in an acid medium by exposure to visible light or the mechanism of oxyreduction.[20] Similar results were found in studies carried out by **Yilmaz Y et al [12], Tyagi M et al[21], Panthri P et al[22], Kaur J et al[23] Kalaskar R et al[24]** who assessed and compared the retentive strength of Glass ionomer cement, Resin modified glass ionomer cement and Dual polymerizing self-adhesive resin cement and found bond strength of resin cement to be maximum than resin modified glass ionomer and glass ionomer cement.

Mowafy OE[25] stated that it had lower bond strength to tooth structure as compared to resin cements that use etch and rinse steps and **s**hould not be used in situations where mechanical retention is compromised.

No statistically significant difference is seen between resin modified glass ionomer cement and glass ionomer cement. Similar result has been found in study done by **Yilmaz et al[12,26] Cantekin K et al[27]** who stated that there was no statistically significant difference in mean retentive strength between resin modified glass ionomer cement and glass ionomer cement.

Bora TD et al[28] performed an in vitro study to compare the shear peel bond strength of four different kind of luting agents. They found there was no statistical difference between resin modified glass ionomer and conventional glass ionomer cement.

Conclusion:-

1. The mean retentive strength value for Dual polymerizing self-adhesive resin cement (RelyX U200) was 1 kgF/cm^2, resin modified glass ionomer cement (RelyX luting 2) was 0.5120kgF/cm^2 and glass ionomer cement (GC Fuji 1) was 0.5240kgF/cm^2.
2. Dual cure self-adhesive resin cement (RelyX U200) showed highest retentive strength than resin modified glass ionomer cement (RelyX Luting2) and glass ionomer cement (GC Fuji I)
3. There was no statistically significant difference present in retentive strength between resin modified glass ionomer cement and glass ionomer cement

Regardless of the utmost care taken in conducting this study efficiently, further research is still necessary with a larger sample size.

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