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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF MICROLEAKAGE AND RETENTION OF DIFFERENT LUTING AGENTS USED FOR CEMENTING CUSTOM MADE STAINLESS STEEL BANDS ON MOLARS-*AN IN VITRO STUDY*

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Abstract

Aim: The aim of this study was to evaluate the microleakage and retentive strength of various luting agents.

Material And Method: Forty samples were randomly divided into group A (assessment of microleakage of different luting agents) and B (assessment of the retentive strength of the different luting agents) with 20 samples each. Both Group A (assessment of microleakage of different luting agents) and B (assessment of the retentive strength of the different luting agents) were further subdivided into group A1, A2, A3 and A4 & B1, B2, B3 and B4 respectively with 5 samples each. Group A1, B1- ZINC PHOSPHATE(CONTROL GROUP)Group A2, B2 - SPEED CEM PLUS Group A3, B3 - HY BOND CX SMART GLASIONOMER Group A4, B4- NO CEMENT (NEGATIVE GROUP)

Results: Speed CEM Plus has the lowest mean value while zinc phosphate has the highest mean value of microleakage. While it was noted that Speed CEM Plus had the highest mean value while zinc phosphate has the lowest mean value of retentive strength

Conclusion: Speed CEM Plus can be recommended as a potential and efficiency luting cement material in term of lower microleakage and high retentive strength for cementing stainless steel band on molar.

Introduction:-

The primary dentition plays a very important role in the child's growth and development, not only in terms of speech, chewing, appearance and the prevention of bad habits but also in the guidance and eruption of permanent teeth.[1]Exfoliation of primary teeth and eruption of permanent teeth is a normal physiological process[2]. When this normal process is disrupted, due to factors like premature loss of primary teeth, proximal carious lesions etc, it may lead to mesial migration of teeth resulting in loss of the arch length which may manifest as malocclusion in permanent dentition in the form of crowding, impaction of permanent teeth, supraeruption of opposing teeth etc.Therefore, the best way to avoid these problems is to preserve the space created by the premature loss of the primary teeth in the arch by space maintainers.[3]

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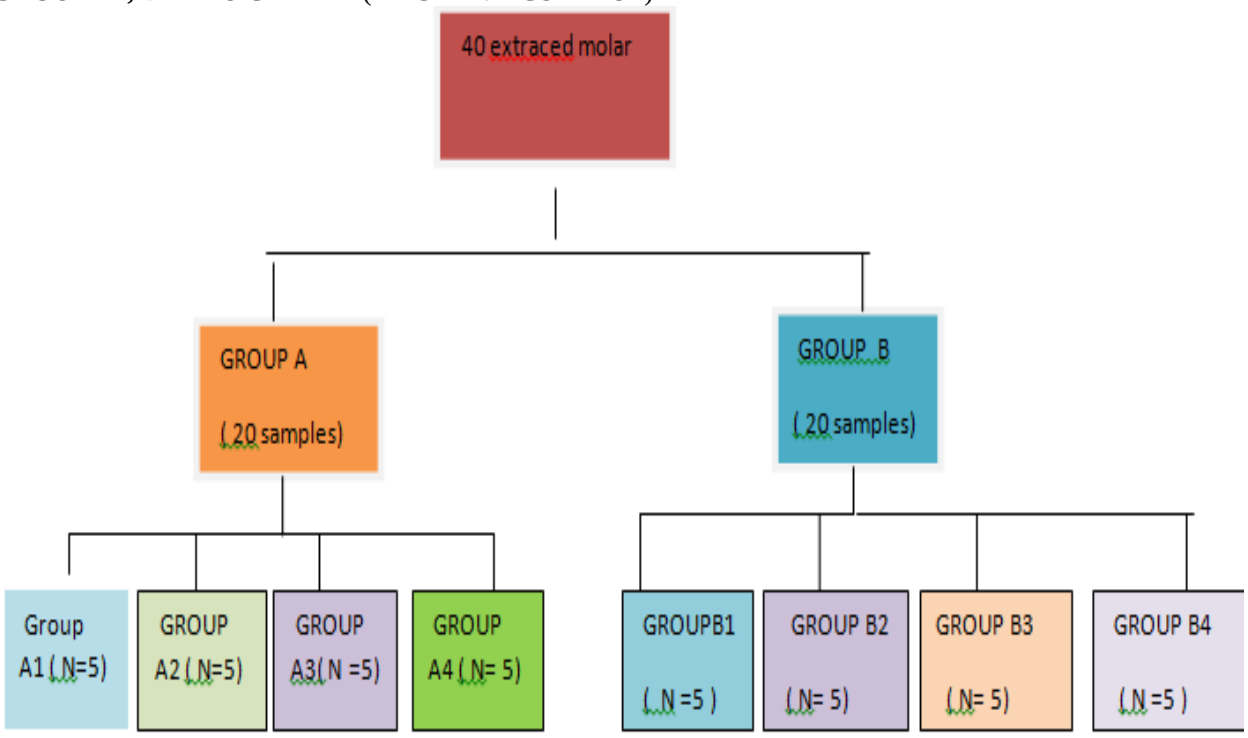
Stainless steel bands are frequently used to adapt on abutment molars in case of fixed space maintainers. Although stainless steel bands have a high clinical success rate, a key reason for its clinical failure is debonding of the space maintainer due to cementation failure.[4] Cement disintegration through its decomposition or dissolution in oral fluids, shrinkage on setting[5], the strength and weakening of the bond between the cement and dentine or cement and restoration are reported as possible causes of microleakage and loss of bonding effect. Therefore, luting agents that are frequently used in paediatric dentistry primarily for the cementation of stainless steel bands of fixed space maintainers should have effective characteristics. For almost 100 years only zinc phosphate cement was available, which is still being considered the "gold" standard.[7]In 1969, a new translucent cement was developed by Wilson and Kents based on acid–base reaction between aluminosilicate glass powder and an aqueous solution of polymers and copolymers of acrylic acid, including itaconic,maleic, and tricarboxylic acid.[8]This cement was given the genetic name Glass-ionomer cement (GIC) and the trivial name was ASPA (Aluminosilicatepolyacrylate) and the word 'Ionomer' was coined by the Dupont company to describe its range of polymers containing a small proportion of ionized or ionizable groups[9], generally of the order of 5–10%and since then many modifications came up, one of the latest innovation being HY Bond Glasionomer CX-Smart which has proven its efficacy in terms of both microleakage and retention. Another self adhesive based mechanism luting agent that has come up is, SpeedCEM Plus which is a self-adhesive resin cement that bond to dentin and can be used in both a self-cure and dual-cure mode.SpeedCEM Plus promises to achieve high bond strength values even on excessively dry dentin in conjunction with both the self-cure and light-cure mode.

Material And Method:-

Forty samples were randomly divided into group A(assessment of microleakage of different luting agents) and B (assessment of the retentive strength of the different luting agents) with 20 samples each. Both Group A and B were further subdivided into group A1, A2, A3 and A4 & B1, B2, B3 and B4 respectively with 5 samples each.

The samples were randomly divided into the following four groups and prepare for microleakage evaluation and retentive strength evaluation (Flowchart 1).

GROUP A1, B1- ZINC PHOSPHATE (CONTROL GROUP)
GROUP A2, B2 - SPEED CEM PLUS
GROUP A3, B3 - HY BOND CX SMART GLASIONOMER
GROUP A4, B4- NO CEMENT (NEGATIVE CONTROL)



Flow Chart 1:- Division Of Samples

Methodology:-

A)For microleakage evaluation

In group A, (A1, A2, A3, A4),Stainless steel band will adapted on to the permanent molars then mixing of cement and cementation of luting agent was done by using different luting cement as divided among various group (A1,A2,A3). except in group A4, no cementation was done.After cementing of all the samples with the respective luting agent, they were subjected to thermocycling to simulate oral conditions . In group A sticky wax was applied in all the samples. One by fourth of the root apex in order to prevent dye penetration from apical thirdof the root portion.Exposed portion of crown and root surfaces will be painted with nail varnish and kept in methylene blue for 48 hour. Then the sample were cut buccolingually into two halves separating mesial and distal surface.Section will be then investigated for microleakage using steromiscroscope.

B) For retentive strength evaluation

While in group B,(B1,B2 , B3,B4) all the sample were mounted in acrylic blocks with root embedded in the block while the crown portion is exposed,then small holes were made on mesial and distal surfaces of the selected ss band using high speed hand piece and straight bur and ligature wires were passed through the holes on both the surfaces, one on mesial aspect and the other on distal aspect.All the four ends of wire were tied together making an arch so that it was easy for machine to pull the band while retention and in the end of group B (B1,B2,B3,B4) mixing and cementation was done similar as group A except in group B4 which no cementation was done. All the samples were then sent to the laboratory for the assessment of retentive strength.

Result:-

The mean value of microleakage was 1.20 for group A1, 0.20 for group A2, 0.40 for group A3 , 2.20 for groupA4. It was noted that group A2 (Speed CEM Plus) had the lowest mean value of 0.20 while group A4 (no cement) had the highest mean value of microleakage ,i.e 2.20. (Table 1) When intergroupcomparision of mean of microleakage were done using post hoc group A1vs A2, group A4 vs A3, group A1 vs A4, Group A2vs A3, Group A2 vs A4, Group A3 vs A4 was found to be highly significant except group A2 vs A3 were non significant. (P = 0.01) (Table 2) while the mean value of retentive strength was 52.80 was for group B1, 86.20 for group B2 , 79.00 for group B3,18.00 for group B4 (No cement) It was noted that group B2 (speed CEM PLUS) was the highest mean value of 86.20 while group B4 (no cement) had the lowest mean value of retentive strength. i.e 18.00 . (Table 3) When intergroup comparision of mean of retentive strength were done using post hoc group B1vs B2, group B1 vs B3, group B1 vs B4 group B2 vs B4,B3 vs B4 was found to be highly significant. (Table 4)

GROUP	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Group A1(Zinc phosphate)	1.20	0.836	0.374	.00	2.00
Group A2 (Speed CEM Plus)	0.20	0.447	0.200	.00	1.00
Group A3(HY Bond glasionomer CX smart)	0.40	0.547	0.244	.00	1.00
Group A4(No Cement)	2.20	0.836	0.374	1.00	3.00

Table 1:- Mean value of microleakage.

	Mean Diff	Std error	P value	Significance
Group A1 vs Group A2	1.000	0.435	0.036	Significant
Group A1 Group A3	0.800	0.435	0.045	Significant
Group A1vs Group A4	1.000	0.435	0.036	Significant
Group A2 vs Group A3	0.200	0.435	0.653	Non-Significant

Group A2 vs Group A4	2.000	0.435	0.000	Significant
Group A3 vs Group A4	1.800	0.435	0.001	Significant

Table 2:- Intergroup comparision of mean of microleakage.

GROUPS	Mean	Std. deviation	Std.Error	95% confidence interval for mean			
				(Lower Board	Upper Board	Min	Max
Group B1(Zinc Phosphate)	52.80	2.683	1.200	49.468	56.131	50.00	56.00
Group B2(Speed CEM plus)	86.20	3.633	1.624	81.688	90.711	82.00	90.00
Group B3(HY Bond CX Smart)	79.00	7.314	3.271	69.918	88.082	71.00	87.00
Group B4(No Cement	18.00	1.870	0.836	15.677	20.322	16.00	20.00

Table 3:- Mean value of retentive strength among various groups.

	Mean	**Std Dev**	**Std Error**	**Mean Diff**	**P value**
Group B1	52.80	2.683	1.200	33.400	0.001 (Sig)
Group B2	86.20	3.633	1.624		
Group B1	52.80	2.683	1.200	26.200	0.001 (Sig)
Group B3	79.00	7.314	3.271		
Group B1	52.80	2.683	1.200	34.800	0.001 (Sig)
Group B4	18.00	1.870	0.836		
Group B2	86.20	3.633	1.624	7.200	0.020 (Sig)
Group B3	79.00	7.314	3.271		
				*	.
Group B2	86.20	3.633	1.624	68.200	0.001 (Sig)
Group B4	18.00	1.870	0.836		
Group B3	79.00	7.314	3.271	61.000	0.001 (Sig)
Group B4	18.00	1.870	0.836		

Table 4:- Intergroup comparision of mean of retentive strength.

Discussion:-

In the growth and development of young children, apart from chewing, speaking and maintaining aesthetics, the primary tooth holds space in the jaws for the developing permanent teeth. But in some cases, a deciduous tooth may exfoliate early due to caries or trauma which can result in unwanted movement of adjacent teeth which leads to malocclusion. It is important that the space created by the premature loss of primary teeth be maintained until the eruption of permanent successors.

Success of the space maintainer relies on the close adaptation of bands to the contour of the teeth (i.e., effective marginal seal that enables intimate contact between stainless steel band and tooth). Moreover, bands should have the strength to withstand the occlusal stresses (i.e.retention that defines the correct and permanent position of the fixed restoration).Therefore, luting agents used in pediatric dentistry primarily for the cementation of stainless steel bands of fixed space maintainers should have effective characteristics.

The data was statistically analysed using ONE WAY-ANOVA and POST HOC TUKEY TEST and the following results were obtained.

In case of microleakage ,It was noted that group A2 (Speed CEM Plus) has the lowest mean value of 0.20 while group A4 (no cement) has the highest mean value of microleakage ,i.e 2.20

It was noted that group B2 was the highest mean value of 86.20 while group B4 has the lowest mean value of retentive strength. i.e 18.00

The result from the study revealed that the mean microleakage in cementation of stainless steel bands was least in group A2 (Speeed CEM plus). This can be attributed to the presence of acidic monomers present in the organic matrix. These acidic monomers react with the organic material (72% of the weight) present in hydroxyapatite of enamel and dentin that demineralize tooth structure and bond the two materials by producing micromechanical interlock. Dentin adhesion is obtained by infiltration of resin monomer into the smear layer into underlying dentin, without etching and drying. Moreover, the resin cement contains specific multifunctional phosphoric acid methacrylates which is able to interact with the tooth surface in multiple ways, such as by forming complex compounds with calcium ions or by different kinds of physical interaction like hydrogen bonding or dipole- dipole interaction .The same point has been given by **shrivastava N(2019) [10]** in his study about Comparative Evaluation of Different Properties of Various Luting Agents Used for Cementing Stainless Steel Bands on Molars.

The result also showed less microleakage property with respect to HY Bond Glasionomer CX-Smart. The reason for this might be due to the fact that HY Bond Glasionomer CX-Smart which comprises of a HY-agent, a tannic acid-strontium fluoride-zinc fluoride complex, increases acid resistance and reduce solubility along with its anti-bacterial and anti-enzymatic properties while virtually eliminating hypersensitivity. Moreover, this resin- free cement chemically bonds to tooth structure that makes it responsible for the excellent marginal seal and also sharp set with remarkable moisture tolerance.

When intergroup comparision between various groups was made,Group A3(HY Bond Glasionomer CX Smart has higher microleakage compared to Group A2 (Speed CEM Plus) but it was non significant. Even though HY Bond Glasionomer CX smart belongs to the newer glass ionomers that guarantees reliable cementations for lasting restorations, the acid component of the cement might have demineralized smear layer and also the intact dentin. Since the cement mixture consistency is creamy, it is not capable of diffusing through the demineralized dentin. Moreover, only chemical bonding is taking place.

Zinc Phosphate (Group A1) showed the mean value of microleakage which is the highest microleakage when compared to the other cements used in these study. The difference may be due to the fact that Zinc phosphate has a relatively high solubility in the mouth. It does not provide any chemical bonding to tooth or metal surfaces. Similar reason was given by **Reddy k et al (2010) [11]**in his study on comparative study of retentive strengths of zinc phosphate, polycarboxylate and glass ionomer cements with stainless steel crowns .The same point has been reported by **Memarpour M et al(2010)[12]** in his study on microleakage of adhesive and nonadhesive luting cements for stainless steel crowns.

When intergroup comparision was made, Group A1 (Zinc Phosphate) showed statistically significant difference in terms of microleakage property, when compared with Group A2 (Speed CEM Plus) as well as Group A3 (HY Bond Glasionomer CX Smart) respectively. The reason might be because zinc phosphate has a relatively high solubility rate in the oral fluids when compared to the other luting agents used here, in addition it also does not bond the stainless steel band chemically to the tooth structure.

The results from the study revealed that the mean microleakage values among the luting cements was highest in group IV (No Cement) where no cement was used for cementation. The result of this negative control authenticates that no other factor was involved in the attainment of result.

The Speed CEM Plus can be recommended as a potential luting cement on account of its superior sealing ability when compared to HY Bond Glasionomer CX Smart and Zinc Phosphate. Still further long term clinical trials with more samples are required to authenticate the results.

Retentive strength is another parameter that has been evaluated in this study using instron testing machine.

On evaluating the retentive strength of various groups viz Group B1 (Zinc Phosphate), GroupB2 (Speed CEM Plus), Group B3 (HY Bond Glasionomer CX Smart) and Group B4 (No cement),the mean values were found to be 52.80, 86.20 , 79.00,and 18.00 respectively. This clearly showed that Group B2 (Speed CEM Plus) has the highest retentive strength followed by Group B3 (HY Bond Glasionomer CX Smart),Group B1 (Zinc Phosphate)and minimum in Group B4(No Cement).The result from these study revealed that the retentive strength in cementation of stainless steel bands was highest in group B2 (Speed CEM Plus). This can be attributed due to their property of dual cure as well self adhesiveness. The cement contains methacrylate monomer having phosphoric acid group along with the rheology modifier. The setting reaction starts by light and later by a chemical reaction of the initiator system (dual cure). The radical polymerization that happens when a single monomer molecule is chemically cross-linked to form a three-dimensional polymer network, creates a neutralization reaction which enhances long-term stability. This is in accordance to the study done by **shrivastava** N **et al in(2019)** [10] on Comparative evaluation of different properties of various luting agents used for cementing stainlesssteel bands on molars.

The result also showed good retentive property with respect to HY Bond Glasionomer CX Smart. The reason could be attributed to the fact that the cement comprises a HY-agent , which is a tannic acid-strontium fluoride-zinc fluoride complex that is known to release fluoride and thus promote mineralization. Furthermore the cement also bonds chemically to the tooth structure thus enhancing its retentive strength with the stainless steel band ,increase acid resistance and also reduce solubility with anti-bacterial and anti-enzymatic properties while virtually eliminating hypersensitivity. This cement is resin free & chemically bonds to tooth structure for excellent marginal seal and sharp set with remarkable moisture tolerance.

When intergroup comparision was made, statistically significant differences were obtained among all the groups. Group B3(HY bond Glasionomer CX smart) showed statistically significant lesser retention when compared to Speed CEM Plus. This can be attributed to the chemical bonding of the cement with the tooth surface achieved by self adhesive luting technology, whereas in Speed CEM Plus a dual cure reaction is taking place.

Zinc Phosphate has got statistically lower retentive feature among all the experimental groups. Difference may be due to the fact that zinc phosphate cement lies on mechanical interlocking for its retentive effect and on close physical adaptation for sealing restorative margins, but it does not provide any chemical bonding to tooth or metal surfaces. This is in accordance with the study done by **Reddy MR et al (2010)**[13]on Comparative evaluation of retentive strengths of zinc phosphate, polycarboxylate and glass ionomer cements with stainless steel crowns. Similar reason was also given by **Gorodovsky S et al (1992)**[14] in his study on Retentive strength, disintegration, and marginal quality of luting cements.

When intergroup comparision was made, the Speed CEM Plus showed statistically significant greater retentive feature in comparison to Zinc phosphate cement, the reason could be due to its robust matrix system that resists crack propagation and greater acid resistance, making it applicable for long term stability.

The results from the study revealed that the mean retentive forces among luting cements was lowest in group IV (NO CEMENT) where no cement was used for cementation. The result of the negative control authenticates that no other factor was involved in attainment of the result.

When all the four luting agents are compared, Speed CEM Plus show the best result for microleakage ie minimal microleakage and also best result for retentetive strength ie the maximum retentive strength. On the other hand Zinc phosphate cement showed minimal microleakage and retentive strength.

Thus on the basis of the results obtained , it can be concluded that the Speed CEM Plus could be recommended as a cementing material for stainless steel bands due to its less microleakage and high retentive strength when compared to HY Bond Glasionomer CX Smart and Zinc Phosphate

Concusion:-

On the basis of the study done,Speed CEM Plus can be recommended as a potential and efficiency luting cement material in term of lower microleakage and high retentive strength for cementing stainless steel band on molar.

However, further studies as well as clinical trials should be conducted using a large sample size to further evaluate the microleakage and retentive strength assessment for different luting cements used.

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