A Comparison of Efficacy of Lingual Retainer Wires Bonded With Different Adhesive Systems – An In-Vitro Study

Dr.Sathyadeep.V[1], Dr.Hemanth.M[2], Dr.Sachin Shaji M[3], Dr.Karthik J Kabbur[4], Dr.Sharmada.BK[5]
Department of Orthodontics and Dentofacial Orthopedics, Dayananda Sagar College of Dental Science
Kumaraswamy layout, Bangalore

Abstract:-

➢ ***Objective*:**

We compared the forces required to debond and assessed the amount of wire deformation after debonding and also compared the adhesive remnant index of lingual bonded retainers fabricated using co-axial wire and braided rectangular wire with two adhesive systems.

➢ ***Methods*:**

We tested Co axial wire bonded with packable composite (Group A1), Co axial wire bonded with flowable composite (Group A2), Braided wire bonded with packable composite (Group B1) and Braided wire bonded with flowable composite (Group B2).To evaluate the detachment force, deformation and the Adhesive Remnant Index, we embedded 80 upper and lower extracted incisor teeth in acrylic blocks in pairs and divided into 4 groups of 10 sample each. The retainer wires were bonded to the teeth and vertically directed forces were applied using universal testing machine to the wire to test the pull out force. Wire deformation was recorded using a Universal Testing Machine during debonding procedure. The amount of adhesive remaining in tooth after wire debonded was assessed using ARI index.

➢ ***Results*:**

Mean force of higher magnitude was required to separate bonded wire from human incisor (Newtons) was found to be higher in group B2 followed by Group B1, A2 and A1 respectively. Braided wire required force for dislodgement.Higher mean deformation was recorded in Group A2 followed by A1, B1 and B2 respectively.The difference in mean deformation among the groups wasfound to be statistically significant ($P<0.001$). The association between ARI scores and the groups were not statistically significant. ($P\geq0.05$)

➢ ***Conclusion:***

Compared to the other groups, Group B2 was better retained on the teeth due to its higher bond strength. Group A2 showed the greatest deformation when compared to other groups. The association between ARI scores and the groups were not statistically significant.

Keywords: *lingual retainers, bond strength, deformation*

I. INTRODUCTION

Retention is necessary after orthodontic treatment to overcome the recoil of the periodontal supporting fibers and to allow remodeling of the alveolar bone.[1] Traditionally, removable appliances are used for post treatment retention but as these appliances are patient compliance dependent, esthetically poor and bulky, there is a trend towards fixed lingual bonded retainers.

Lingual retainers are an effective means of retaining aligned anterior teeth in the post-treatment position in the long term. A number of different designs and techniques for placement have been suggested.[2] Different wires are proposed to be used for lingual bonded retainers. As these wires are intended to serve for long term in the mouth, attempts have to be made to increase the success rate of the retainers .Zachrisson introduced flexible spiral wire retainers (fswrs). These retainers use a multistranded wire and include all anterior teeth. The flexibility of the wire reduces the concentration of stress within the bonding composite, thus minimizing the risk of subsequent failure.[3] Composites used in the lingual aspect typically fail because internal crack propagation or thinning out of composites occurs due to abrasion. Abrasion occurs due to food habits and brushing.[4]

Traditional packable composites have been used for a long time as it has a good filler content , which is resistant to abrasion. But it is time consuming to use them in the lingual aspect where isolation is of great importance.

Flowable composites have numerous advantages over traditional composites .they permit direct placement on the retainer wire, non-sticky, no trimming or polishing is required and they reduce chair side time. Flowable composites with nano-sized filler particles are promising as they have a good filler content per unit volume, higher abrasive resistance compared to the traditional micro filled flowable composites.[5]

However, the failure rate of lingual retainers is a problem of great concern as frequent debonding of these retainers can lead to relapse. Hence, this study is undertaken to evaluate the detachment force for the fixed retainers, amount of deformation during fracture and amount of composite on surface of tooth after detachment of two wires used for lingual bonded retainer (coaxial wire and braided rectangular wire) when bonded with two adhesive systems (flowable and packable composite).

II. MATERIAL & METHODS

This study was carried out in Dayananda Sagar College of Dental Sciences and Composite technology park, Bangalore

The material for the study comprised of 80 extracted human incisors teeth collected from the Department of Oral and Maxillofacial Surgery, Dayananda Sagar College of Dental Sciences , Bangalore

Eighty upper and lower extracted incisor teeth were obtained from patients who were undergoing extraction. Teeth with caries, cracks or abnormalities were excluded. Soft tissue remnants were removed with a ultrasonic scaler and teeth were stored in preservative solution. Pairs of teeth were matched to form a contact area that mimics the intraoral situation. Chemically cured acrylic resin was placed into molds and the roots of the teeth were embedded in the acrylic. The tooth were mounted so that the long axis were perpendicular to the base of the molds. In total, 40 blocks were constructed.

The teeth were polished with pumice, the blocks were divided in 4 groups of 10 sample each.

- Group A1 - Co axial wire bonded with packable composite
- Group A2 - Co axial wire bonded with flowable composite
- Group B1 - Braided wire bonded with packable composite
- Group B2 - Braided wire bonded with flowable composite.

The tooth were etched for 30 seconds with 37% ortho-phosphoric acid, then rinsed with water for 30 seconds using a three-way syringe, and dried for 20 seconds using an oil-free air source.
Then the Primer was applied, in accordance with the manufacturer's instructions and cured. To provide best fit of the wire over the tooth, a gentle curve was given.

A 10 mm length of test wire was cut and the midpoint of the wire was marked with a pencil. The test wire was then placed on the primed tooth surface.

The adhesive was applied with mini mold which was 4 mm in diameter with a 1.5 mm depth which provided a 12.6 mm^2 bond area on each tooth and cured in accordance with the manufacturer's instructions using a light curing unit.

The same procedure was repeated for all the other blocks.

➢ *Debonding Procedure*

Specimens were secured in a jig attached to the base plate of Universal Testing Machine. A chisel-edge plunger was mounted in the movable crosshead of the testing machine and positioned so that the leading edge aims at the marked midpoint of the wire. The chisel-edge wascarefully placed so that it should not contact any part of the specimen. The crosshead speed was set to 1 mm/ min and the maximum load necessary to debond the wire was recorded for each specimen.

Wire deformation was recorded using a Universal Testing Machine during debonding procedure for all the specimens.

The amount of composite left on the surface of each specimen was recorded using ARI index to find out the interface where the fracture is happening. In this system, fractures are ranked from 0 to 3, based on amount of adhesive remaining in tooth after wire debonded.

- 0-No adhesive remaining on the enamel surface
- 1-Less than 50% adhesive remaining on tooth surface.
- 2-More than 50% adhesive remaining on tooth surface.
- 3-All adhesive remaining on tooth surface .

III. STATISTICS

This study was conducted to evaluate the detachment force for the fixed retainers, amount of deformation during fracture and amount of composite on tooth surface after detachment of two wires used for lingual bonded retainer (Coaxial wire and Braided rectangular wire) when bonded with two adhesive systems (Flowable and Packable composite). The material for the study comprised of 80 incisor teeth which were embedded in acrylic blocks in pairs ,in total 40 blocks were made which were divided into four groups of 10 specimen each.

For this study the null hypothesis was stated that there is no significant difference in the mean force (max force) recorded in the four groups i.e. $\mu_1 = \mu_2 = \mu_3 = \mu_4$ .The alternate hypothesis was stated that there is a significant difference in the mean force (max force) recorded in the four groups i.e. $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq$.

The level of significance was taken as α=0.05

The statistical technique which was used is analysis of variance (ANOVA).

An ANOVA test is a way to find out if survey or experiment results are significant. In other words, they help to figure out if you need to reject the null hypothesis or accept the alternate hypothesis. It is a test for groups to see if there's a difference between them. Decision criterion is to reject the null hypothesis if the p-value is less than 0.05. Otherwise we accept the null hypothesis. If there is a significant difference between the groups, we carry out multiple comparisons (post-hoc test) using bonferroni test to find out between which group the difference exist.

IV. RESULTS

Retention of treated malocclusion is one of the most important after debonding, which can be achieved using removable or fixed appliance. Removable appliance being patient compliance dependent fixed retainer using lingual retainer has gained popularity. Different wires are used for lingual retainer fabrication. The failure rate of lingual retainers is a problem of great concern as frequent debonding of these retainers can lead to relapse. Hence, this study is aimed to evaluate the detachment force for the fixed retainers, amount of deformation during fracture and amount of composite on tooth surface after detachment of two wires commonly used for lingual bonded retainer (Coaxial wire and Braided rectangular wire) when bonded with two adhesive systems (Flowable and Packable composite). To find out which wire composite combination will give best result we embedded 80 incisor teeth which were embedded in acrylic blocks in pairs. Then blocks were divided into 4 groups of 10 samples each.Four groups which were considered in the study are as follows

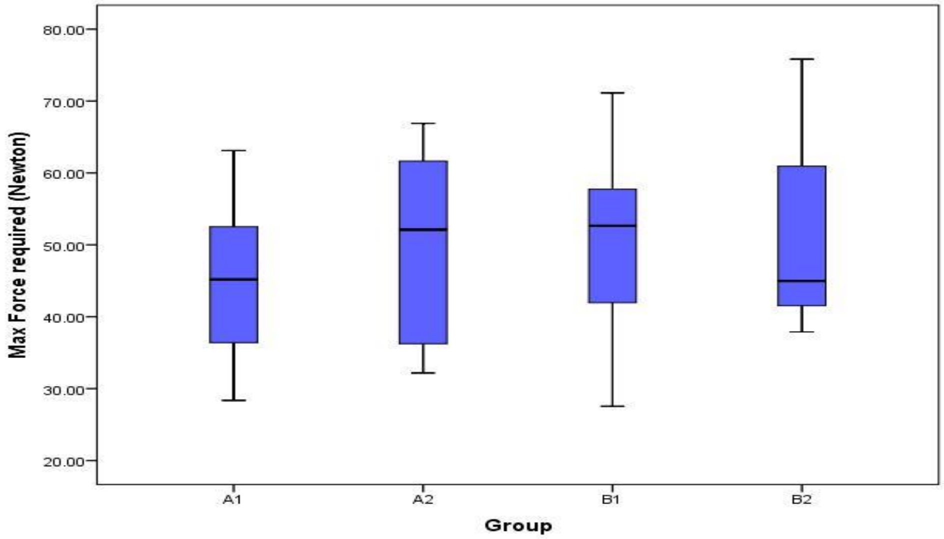
- Group A1 - Co axial wire bonded with packable Composite
- Group A2 - Co axial wire bonded with flowable composite
- Group B1 - Braided wire bonded with packable Composite
- Group B2 - Braided wire bonded with flowable composite.

Test was conducted to measure the debonding force using universal testing machinethe results of the test are given in table 1 and graph 1.

Group	Mean	StdDev	SE of Mean	95% CI for Mean		Min	Max
				Lower Bound	Upper Bound		
A1	45.04	11.52	3.64	36.80	53.28	28.37	63.12
A2	49.47	14.01	4.43	39.44	59.49	32.19	66.90
B1	50.36	12.14	3.84	41.67	59.04	27.55	71.14
B2	50.87	12.81	4.05	41.70	60.03	37.89	75.83

Table 1:- Mean force (max force) recorded in the groups

Mean force taken for debonding was found to be higher in B2 group followed by B1 and A2, least force for debonding was exhibited by A1 as shown in graph 1 and table 1.



Graph 1:- Mean force (max force) recorded in the groups

The results shown in Table 1 were subjected to ANOVA and it was found that even though mean force required to separate bonded wire from incisor (in Newtons) was found to be higher in group B2 followed by Group B1, A2 and A1 respectively, the difference in mean force among the groups was not found to be statistically significant p=0.725 which was greater than 0.05 as shown in table 2.

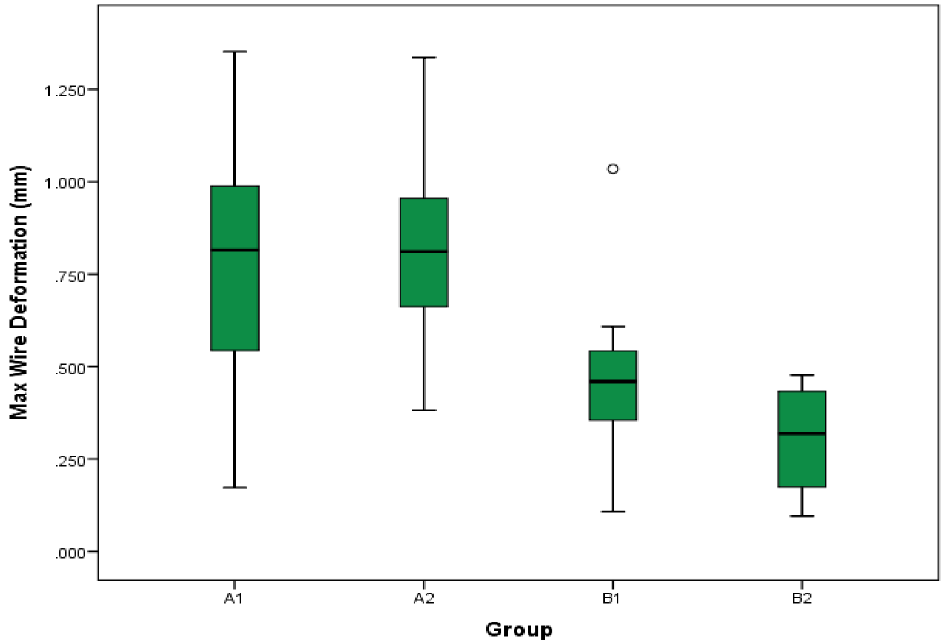
Source of Variation	Df	Sum of Squares	Mean Square	F	P-Value
Between Groups	3	212.087	70.696	0.441	0.725
Within Groups	36	5764.775	160.133	---	---
Total	39	5976.863	---	---	---

Table 2:- Mean Force (Max Force) Recorded in Between Groups and Within Group Using ANOVA

Wire deformation that occurred on debonding in different groups are shown in Table 3 and graph 2.It was seen that the mean deformation was least in B2 followed by B1, A1 and the highest deformation was recorded in A2.

Group	Mean	StdDev	SE of Mean	95% CI for Mean		Min	Max
				Lower Bound	Upper Bound		
A1	0.800	0.367	0.116	0.538	1.063	0.173	1.352
A2	0.819	0.251	0.079	0.640	0.999	0.382	1.336
B1	0.471	0.248	0.078	0.293	0.648	0.108	1.035
B2	0.310	0.142	0.045	0.208	0.411	0.095	0.477

Table 3: Mean Deformation (Mm) Recorded in the Groups



Graph 2: Mean Deformation (Mm) Recorded in the Groups

The results of wire deformation obtained on debonding in different groups were subjected to ANOVA and the results are shown in Table 4.

Source of Variation	Df	Sum of Squares	Mean Square	F	P-Value
Between Groups	3	1.892	0.631	9.029	<0.001*
Within Groups	36	2.515	0.070	---	---
Total	39	4.408	---	---	---

Table 4: Mean Deformation (Mm) Recorded in Between Groups and Within Group

The results of the table 4 suggested that there was statistically significant difference in mean deformation on debonding present among the groups with the p value of < 0.001.

The results were then subjected to multiple comparisons using Bonferroni test in order to find out among which pair of groups there exist a significant difference,the results of which are given in table 5.

Group (I)	Group (J)	Mean Difference (I-J)	P-Value	95% CI for Mean Difference	
				Lower Bound	Upper Bound
A1	A2	-0.019	1.000	-0.349	0.311
	B1	0.330	0.050	0.000	0.660
	B2	0.491	0.001*	0.161	0.821
A2	A1	0.019	1.000	-0.311	0.349
	B1	0.349	0.033*	0.019	0.679
	B2	0.510	0.001*	0.180	0.840
B1	A1	-0.330	0.050	-0.660	0.000
	A2	-0.349	0.033*	-0.679	-0.019
	B2	0.161	1.000	-0.169	0.491
B2	A1	-0.491	0.001*	-0.821	-0.161
	A2	-0.510	0.001*	-0.840	-0.180
	B1	-0.161	1.000	-0.491	0.169

Table 5: Mean Deformation (Mm) Recorded To Find Out Among Which Pair Of Group There Exist A Significant Difference

ISSN No:-2456-2165

The difference in mean deformation (mm) was found to be statistically significant between Group A1 & Group B2 (P<0.01), Group A2 & B1 (P<0.05) as well as between Group A2 & Group B2 (P<0.01) as shown in table 5.

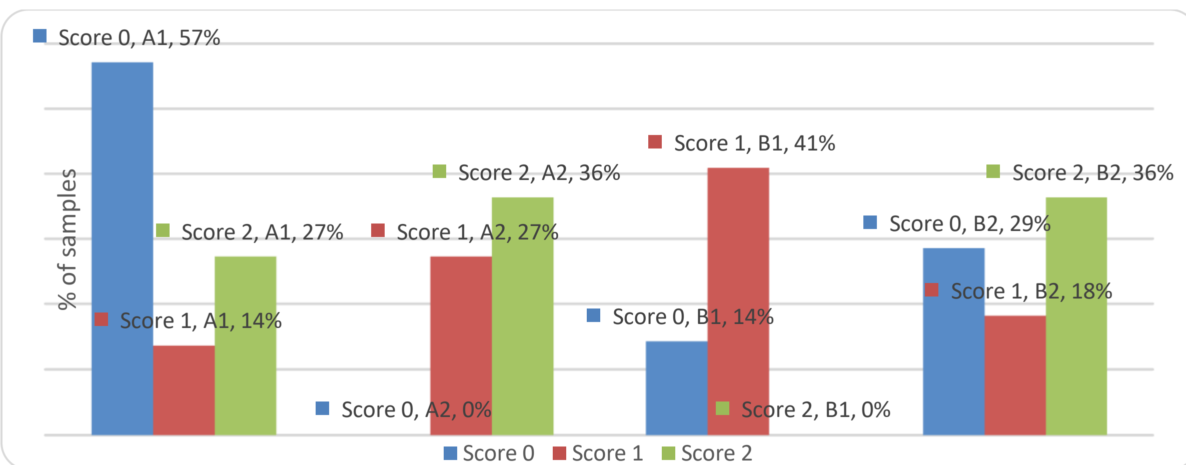
Test was conducted to find out the amount of adhesive remaining on the tooth surface after debonding using ARI score and the results were subjected to chi square test as shown in table 6.

Group	Score 0		Score 1		Score 2		χ^2	P-Value
	N	%	N	%	N	%		
A1	4	57%	3	14%	3	27%	12.727	0.050
A2	0	0%	6	27%	4	36%		
B1	1	14%	9	41%	0	0%		
B2	2	29%	4	18%	4	36%		
Total	**7**	**100%**	**22**	**100%**	**11**	**100%**		

Table 6: Analysis Of ARI Scores: (Chi-Squared Test)

The results of table 6 and graph 3, shows that even though high ARI scores were found in B2 and low ARI scores were seen A1, the results didn't show statistical significance.

According to the results explained in table 2, table 4, table 5 and table 6, the null hypothesis was accepted in the case of mean force required for debonding the lingual retainer, which was not statistically significant between the groups suggesting there is no difference in debonding force between coaxial and braided wire when used along with different composite combination. The null hypothesis was accepted in relation to the ARI scores between the group which was also not statistically different suggesting that the mode of fracture between wire and composite was similar between groups having almost similar amount of composite remaining on tooth surface after dedonding. The null hypothesis was rejected and the alternate hypothesis was accepted in the case of wire deformation caused on debonding of lingual retainer, as there was statistically significant difference between the groups.



Graph 3:- ARI Scores in the groups

V. DISCUSSION

Achieving stability is an important aspect of active orthodontic treatment that continues even into the retentive phase. Active orthodontic treatment achieves stability by moving teeth to establish proper occlusion within the limits of normal muscle balance with due consideration of apical base/bases and the relationship of the bases to one another.[6] During retention phase, stability is achieved by reorganization of the gingival and periodontal fibers to the new position of the teeth. Both these mechanisms help to prevent relapse.[7] Lack of stability can lead to loss of either the function or esthetics or both that was achieved during the active phase of treatment.

Apart from gingival and periodontal reorganization, the type of treatment and growth changes that happen after treatment can additionally contribute to relapse. For these reasons, any existing orthodontic control over tooth position and occlusal relationships must be slowly withdrawn to reduce the chances of relapse.[1,8,9] Hence, long-term preservation of anterior teeth in their aligned position with fixed retainers is essential and the type of retention must be included in the initial treatment plan depending upon the severity of malocclusion and the amount of changes planned to be brought about by active treatment.

Using fixed lingual retainers to maintain the results achieved with orthodontic treatment is now a common procedure. The greatest advantage of using this type of retainer is that no patient compliance, unlike with removable retainers. The main disadvantage is the risk for breakage and failure of these retainers. Gottle et al reported that 81% of surveyed orthodontists use bonded lingual retainers, of which 37% use them routinely and 44% on occasion. Previous studies have examined different variables in attempts to enhance the survival of these retainers.[10]

The studies on orthodontic brackets showed that a bond strength of 6–8 MPa were sufficient to withstand orthodontic forces while the normal oral loading was between 3 and 18N. But very little information is available on the minimum clinically acceptable bond strength in relation to bonded retainer wires.[11,12]

Retainer failure using either different composite or different wire combination using variables either debonding force and deformation caused was tested. There are very few studies which have compared different wire combination with different composite and bonding agent combination together, in relation to debonding force and deformation caused and type of failure caused at tooth and retainer interface. Also while most of the published studies tested materials by loading method applied directly at the bonding site of the orthodontic attachment, very few authors have examined the wire's interdental segment.[13]

In the present study we simulated the clinical bite situation by applying a vertical force on the retainer. Reynolds et al found that a vertical force yields the highest values of bond strength compared to a tensile force in horizontal or vertical orientation. However, bond strength not only depends on the direction, but also on the location of the applied force. Several authors have demonstrated that the lowest values of bond strength occur when the force is applied to the interdental segment. Therefore we chose this most fragile segment to determine the lowest strength required for debonding.[14]

Recently use of flowable composites has been suggested for bonding lingual retainers, when compared to conventional composite and almost every dental manufacturer now has its own flowable composite. So in the present study both packable and flowable composite were used along with different wire combination. This study aimed at identifying the most reliable wire-and-composite combination thus has considerable clinical implications.

The samples in the study were limited to 80 human mandibular and maxillary incisors, the most frequent sites for bonded retainers, and teeth were divided into 4 groups. Group A1 - Co axial wire bonded with packable Composite, Group A2 - Co axial wire bonded with flowable composite, Group B1 - Braided wire bonded with packable composite, Group B2 - Braided wire bonded with flowable composite.

In the present study, the mean in vitro force was applied interdentally and it was found out that,mean force required to separate bonded wire was found to be higher in group B2(Braided wire bonded with flowable composite) 50.87N followed by Group B1(Braided wire bonded with packable composite) 50.36 N, A2(Co axial wire bonded with flowable composite) 49.47 N and A1(Co axial wire bonded with packable composite) 45.04N respectively given in table 1 and graph 1. Zain et al. (2004) found that force application directly to the adhesive pad of a wire/bond combination yielded a higher mean force for failure of 64.3N among all the groups which included wires Dentaflex co-axial 0.018", Dentaflex multistranded 0.018", and Respond Dead Soft straight, length 0.0175"; composites: Tetric Flow and Heliosit Orthodontic.[14] However, the difference in mean force among the groups was not found to be statistically significant similar to study done by Baysal et al, Foek et al[14,15]. Some studies showed statistically significant difference among groups like studies done by Aldrees et al. In that study, the wire was taken was flexible coaxial wire and solid wire and this can be the reason in difference in the results.[16]

To accurately score the ARI is important because it is an important factor to be considered in the selection of orthodontic adhesive. Studies have debated whether the differences in ARI scores reflect a difference in bond strength between the enamel and the adhesive for the different adhesive systems, but adhesive systems that show less adhesive remnant on the tooth has been advocated for easier and safer removal of residual resin after debonding. [17]

Artun et al favoured use of a 0.0205 inch diameter five stranded twisted wire and postulated that the use of five rather three strands reduced the tendency of stress fracture of the wire, whilst Rose et al. (2002) used a 0.0175 inch multi-stranded wire. [17]

A study done by Cooke et al measured deflections in conjunction with the ARI scores. It was suggested that the force experienced by these flexible interdental wires dragged the wire and deformed the interdental segment, leading to propagation of cracks within the composite, most likely along the wire–composite interface, and subsequent bond failure at the wire–composite interface i.e. cohesive failure.[13]

In the present study, more than 50% of sample shows ARI index score 1. ie, less than 50% adhesive remained on the tooth surface which advocated easy removal of lingual retainer on debonding. In the present study the association between ARI scores and the groups was not statistically significant which states that lingual retainer when used with flowable or packable have similar ARI scores are shown in table 6 and graph 3, which suggest that we can select adhesive according to clinical preferences.[17]

A study was done by K W Lumsden et al showed that, breakage appears unrelated to materials used or to the age and sex of patients. The upper retainers break more often than the lower retainers and that the early breakage is more likely to occur at the adhesive pad than at the wire.[14] But on the contrary a study was done by Paolone to assess the retention forces and mechanical behavior of different types of wires matched with different kinds of composites in lingual retainers. The results showed that the bonding between wires and composites in lingual fixed retainers seemed to be lowest for rectangular smooth wires and increased in round twisted and rectangular twisted wires where the bonding was so strong that the maximum tension/bond strength was greater than the ultimate tensile strength of the wire. The highest values were in rectangular twisted wires. Concerning the composites, hybrid composites had the lowest interface bonding values and broke very quickly, while the nano- and micro-composites tolerated stronger forces and displayed higher bonding values. The results of this study show that, when selecting a lingual retainer in daily clinical practice, not only must the patient's compliance and dependability be considered but also the mechanical properties and composition of different combinations of composites and wires.[18]

In the present study wire deformation that occurred on debonding in different groups are shown in table 3 and graph 2. It was seen that the mean deformation was least in B2 followed by B1, A1 and the highest deformation was recorded in A2 (mean=0.819mm).The difference in mean deformation (mm) was found to be statistically significant between Group A1 & Group B2 ($P<0.01$), Group A2 & B1 ($P<0.05$) as well as between Group A2 & Group B2 ($P<0.01$) (table 5). Lingual bonded retainer bonded with co axial shows more deformation as compared to braided retainer wire. However co axial bonded with packable composite (group A1) showed a wire deformation which was similar to lingual bonded retainer fabricated with braided rectangular wire and packable composite (B2). This may be attributed to packable composite which was used to bond in both groups.

It is may still be recommended to use braided rectangular wire for fabricating lingual bonded retainer as it shows less deformation. When ever co axial wire is used, it may be better to use along with packable composite as the deformation is comparatively lesser than the flowable composite. According to Cooke et al deformation of two multi-stranded wires bonded to the lingual enamel of lower incisor teeth shows similar mean degrees of deflection of 1.30 and 1.51 mm for the 0.0175 inch and 0.016 × 0.022 inch wires, respectively.[13] According to Baysal et al greater deformations were seen in dead-soft wires and five stranded coaxial wires exhibited less deformation and concluded five-stranded coaxial wires are suggested for use in bonded lingual retainers.[14]

According to Lie Sam Foeket al, the results of in vitro studies can relate to in vivo conditions. This inability to mimic in vivo conditions can be considered as a limitation of the present study.[14] Clinical studies may be needed to assess the effect of saliva, physiologic movement of teeth, functional forces of tongue, and mastication as well as the presence of plaque and calculus.

In this study although there is no difference in mean bond strengths and ARI among the groups, Wire deformation, an important parameter to assess clinical outcome, showed variation among the groups. It can be recommended that braded rectangular wire bonded with flowable composite (Group B2) may be used as the wire of choice while bonding lingual bonded retainers as it showed maximum bond strength, less ARI and minimum deformation.

VI. CONCLUSION

Mean force required to separate bonded wire was found to be higher in group B2 followed by Group B1, A2 and A1 respectively.

Higher mean deformation (max deformation) was recorded in Group A2 followed by A1, B1 and B2 respectively. The difference in mean deformation among the groups was found to be statistically significant ($P<0.001$).

The ARI score is important because it is an important factor to be considered in the selection of orthodontic adhesive. Studies have debated whether the differences in ARI scores reflect a difference in bond strength between the enamel and the adhesive for the different adhesive systems, but adhesive systems that show less adhesive remnant on the tooth has been advocated for easier and safer removal of residual resin after debonding. In this study ARI scores was not statistically significant among all the 4 group which states that lingual retainer when used with flowable or packable have similar ARI scores, which suggests that we can select adhesive according to clinical preferences.

Results of present study recommended to use braided rectangular wire for fabricating lingual bonded retainer as it shows less deformation. When ever co axial wire is used, it is better to use along with packable composite as the deformation is comparatively lesser than the flowable composite.

In this study although there is no difference in mean bond strengths and ARI among the groups; wire deformation, an important parameter to assess clinical outcome, showed variation among the groups. It can be recommended that braided rectangular wire bonded with flowable composite (Group B2) may be used as the wire of choice while bonding lingual bonded retainers as it showed maximum bond strength, less ARI and minimum deformation.

SUMMARY

The present study evaluated the forces required to debond and assessed the amount of wire deformation after debonding and also compared the adhesive remnant index of lingual bonded retainers fabricated using co-axial wire and braided rectangular wire with two adhesive systems .To test the detachment force, deformation and the Adhesive Remnant Index, we embedded 80 upper and lower extracted incisor teeth in acrylic blocks in pairs and divided into 4 groups of 10 sample each .Group A1 - co axial wire bonded with packable composite, group A2 - co axial wire bonded with flowable composite, group B1 - braided wire bonded with packable composite, group B2 - braided wire bonded with flowable composite. Higher mean force required to separate bonded wire from human incisor was found to be higher in group B2 followed by Group B1, A2 and A1 respectively. Braided wire required higher force for dislodgement. Higher mean deformation was recorded in Group A2 followed by A1, B1 and B2 respectively. The difference in mean deformation among the groups was found to be statistically significant. The association between ARI scores and the groups were not statistically significant. In this study although there is no difference in mean bond strengths and ARI among the groups, wire deformation, an important parameter to assess clinical outcome, showed variation among the groups. It can be recommended that braided rectangular wire bonded with flowable composite (Group B2) may be used as the wire of choice while bonding lingual bonded retainers as it showed maximum bond strength, less ARI and minimum deformation.

REFERENCES

[1]. Proffit WR. Contemporary orthodontics. 5th ed. St. Louis, Mo.: Elsevier/Mosby; 2013:754.
[2]. Case CS. Principles of retention in orthodontia. 1920. Am J OrthodDentofacialOrthop. 2003;124(4):352-361.
[3]. Knierim RW. Invisible lower cuspid to cuspid retainer. Angle Orthod. 1973;43(2):218-220.
[4]. Hegde N, Reddy GY. Bonded retainers in Orthodontics: A review.InternationalJourn Of Dental Clinics.
[5]. Littlewood SJ, Millett DT, Doubleday B, Bearn DR, Worthington HV. Orthodontic retention: A systematic review.JOrthod. 2006;33(3):205-212.
[6]. Lundstrom AF. Malocclusion of the teeth regarded as a problem in connection with the apical base. International Journal of Orthodontia, Oral Surgery and Radiography.
[7]. Salzmann JA. Factors in successful orthodontic therapy before and after using appliances. Am J Orthod. 1963
[8]. Moyers EM. Force systems and tissue responses to forces in orthodontics and facial orthopedics (Chapter 13) In Moyers EM. Hand Book of Orthodontics Year Book Medical Publishers. 1988:309-11.
[9]. Graber TM, Vanarsdall RL. Orthodontics: current principles and techniques. CV Mosby; 1994.
[10]. Reicheneder C, Hofrichter B, Faltermeier A, Proff P, Lippold C, Kirschneck C. Shear bond strength of different retainer wires and bonding adhesives in consideration of the pre-treatment process. Head Face Med. 2014; 10:51.
[11]. Reynolds IR. A review of direct orthodontic bonding. British journal of orthodontics. 1975 Jul 1;2(3):171-8.
[12]. Waters NE. Some mechanical and physical properties of teeth. The mechanical properties of biological materials. Symp Soc Exp Biol 1980:99-134.
[13]. Cooke ME, Sherriff M. Debonding force and deformation of two multi-stranded lingual retainer wires bonded to incisor enamel: an in vitro study. Eur J Orthod.. 2010;32(6):741-6.
[14]. Baysal A, Uysal T. Comparison of three different orthodontic wires for bonded lingual retainer fabrication. Korean J Orthod.2012;42(1):39-46.
[15]. Lie Sam Foek DJ, Ozcan M, Verkerke GJ, Sandham A, Dijkstra PU. Survival of flexible, braided, bonded stainless steel lingual retainers: a historic cohort study. Eur J Orthod 2008;30:199-204.
[16]. Aldrees AM, Al-Mutairi TK, Hakami ZW, Al-Malki MM. Bonded orthodontic retainers: a comparison of initial bond strength of different wire-and-composite combinations .J OrofacOrthop.. 2010;71(4):290-9.
[17]. Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment. Am J Orthod. 1984 ;85(4):333-40.
[18]. Paolone MG, Kaitsas R, Obach P, Kaitsas V, Benedicenti S, Sorrenti E, Barberi F. Tensile test and interface retention forces between wires and composites in lingual fixed retainers. IntOrthod. 2015;13(2):210-20.