Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2016;5:3:128-134.

A Comparative Evaluation of Effectiveness and Efficiency of Adhesive Pre-Coated Brackets and Conventional Brackets: A Prospective In-Vivo Clinical Study

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ABSTRACT

Background: **Aim:** The objective of the present study was to compare the efficiency and effectiveness of APC brackets with non APC brackets.

Materials and methods: 14 patients who required upper and lower fixed appliance therapy were selected . All 14 patients bonded with APC and non APC brackets using split mouth technique. The clinical parameters evaluated were time taken to bond APC and non APC brackets, bond failure rate over a period of 3 months, ARI scores of deboned teeth, variation of failures between maxillary and mandibular teeth and anterior versus posterior teeth, time interval of first failure to day of bonding

Results: Showed that bond failure rate of both APC brackets and non APC brackets was statistically insignificant. The percentage of bond failure in mandibular teeth were significantly higher than maxillary teeth and posterior bond failures were significantly higher than anteriors for both bracket systems. Distribution of ARI scores between the 2 bracket types were similar and time saved in bonding brackets using APC brackets was 9 seconds / tooth when compared with non APC brackets which was statistically significant and clinically considerable.

Conclusion: Clinical performance of APC and non-APC brackets were similar and saves considerable chair side time with APC brackets.

Keywords: APC brackets; non APC brackets.

INTRODUCTION

Bonding of orthodontic attachments to enamel has become a routine clinical procedure for over 40 years.[1] The success of fixed appliance therapy depends on attachments having adequate bond strength and a low failure rate. The need to replace the brackets frequently may severely impair the progress of treatment and can be costly in terms of materials and time.[1] Orthodontic attachments are subjected to a large number of forces in the mouth, resulting in a complex distribution of stresses within the adhesive and at its junction with the enamel and the bracket base. Bond strength to enamel will depend on large number of factors including the nature of enamel surface, enamel conditioning, the type of adhesive used, and the shape and design of the bracket base. Furthermore, the clinical time that is required for placing fixed appliances should be as short as possible because orthodontic composite resins involve a series of technique – sensitive steps and require a completely

Received: Mar. 1, 2016: **Accepted:** May. 17, 2016
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pISSN 2278-0076
eISSN 2321-9270

dry field of operation throughout the bonding procedure.[1] In an attempt to improve bond strength, save chair side time and perform faster and easier bonding procedure, light cured adhesive precoated brackets were introduced in 1992 by 3M Unitek Company.

For many years, it was common practice to apply a layer of orthodontic adhesive to the base of directly bonded appliances immediately before the appliances were placed on the tooth. The development of Adhesive Precoated Brackets (APC) have a bonding base upon which the manufacturer has applied a precise quantity of adhesive. The composite used to precoat the bracket is a version of Transbond XT, modified by an increased viscosity.[2]

Cooper et al in 1992 had listed following benefits of adhesive precoated brackets over other systems:

1) Consistent quality and quantity of adhesive.
2) Reduced flash i.e. easier clean up following bonding.
3) Reduced waste during bonding.
4) Improved cross infection control
5) Better inventory control.
6) Individualized packing aids bracket identification and orientation.[3]

OBJECTIVES

1) To compare the clinical failure rate during first three months of treatment between adhesive precoated and non-precoated brackets.
2). To evaluate ARI Scores of debonded teeth and to compare the same in APC and Non-APC brackets.
3) To compare the clinical time taken to bond APC brackets and Non-APC brackets.

MATERIALS AND METHODS

The present, prospective clinical study was conducted to evaluate the effectiveness and efficiency of adhesive pre-coated brackets in comparison with non pre-coated brackets on selected subjects who reported to Department of Orthodontics, College of Dental Sciences, Davangere seeking orthodontic treatment.

Sample Size:

A total of 14 subjects were included in this trial. Prior to the commencement of the trial, all the participants were informed and verbal consent was obtained. All the 14 cases were treated by a single clinician.

Inclusion Criteria:

1) Good general health and good oral hygiene.
2) Patients having permanent dentition (Till first molars)
3) Who required upper and lower fixed arch therapy

Exclusion Criteria:

1) Poor oral hygiene
2) Patients having mixed dentition
3) Enamel hypoplasia.

Assignment[34]:

In all 14 patients a split mouth technique was employed to bond two quadrants with adhesive precoated brackets and other two quadrants with non precoated brackets on enamel conditioned with etchant and primer separately . As a result, all the patients underwent placement of both precoated and non precoated brackets.

Table 1: Comparison of bond failure rate between APC and conventional brackets (non-APC)

Type of Bracket Used	No. of Teeth Bonded	No. of Teeth Failed	Percentage of Bond Failure
APC	119	9	7.6%
Non-APC	119	5	4.2%
p Value	p = 0.27, Not Significant		

* **Chi-square test = 1.21, p = 0.27, NS**

Table 2: Comparison of adhesive remnant index scores (ARI) of APC and non-APC metal brackets.

A.R.I. SCORE	APC		Non-APC	
	Number of Bond Failures	Percentage	Number of Bond Failures	Percentage
0	4	44.4%	2	40%
1	3	33.3%	2	40%
2	2	22.2%	1	20%
3	0	0%	0	0%

Table 3: Presents the bond failure rate of APC and non APC brackets at particular intervals of time.

Bracket Type		First Day		1 Week		15 Days		1 Month		2 Months		3 Months	
	Total	No	%	No	%	No.	%	No.	%	No.	%	No.	%
APC	9	6	66.67	7	11.11	1	11.11	1	11.11	0	0	0	0
Non-APC	5	2	40	2	40	0	0	0	0	1	20	0	0
Overall	14	8	57.14	3	21.43	1	7.14	1	7.14	1	7.14	0	0

Table 4: Comparison of time taken to bond APC and non-APC brackets.

SL.No.	NON-APC Time taken to bond each tooth / patient (Seconds)	APC Time Taken to bond each tooth /patient (Seconds)
1	148.5	141
2	143	135.6
3	145	133.4
4	147.53	141
5	148.3	136.75
6	143	130
7	142.4	138.88
8	141	133.4
9	138.9	129.3
10	139	128
11	146	136.4
12	147.5	140.5
13	142.3	132
14	143	132.75
Mean	143.9592857	134.9271429
SD	4.37	3.24
t-Value	6.2	
p-Value	0.001, S	

Except for molars, all the teeth were bonded. The sample was divided into 2 groups for comparison and to minimize bias.

Group 1: Adhesive precoated brackets were bonded to first and third quadrant and non precoated brackets were bonded to second and fourth quadrant.

Group 2: Adhesive precoated brackets were bonded to second and fourth quadrant and non

precoated brackets were bonded to first and third quadrant.

Intervention[34]:

McLaughlin, Bennet and Trevisi prescription 0.022 slot full sized twin brackets which are available in standard non precoated and precoated versions from 3 M UNITEK Company are used. The light cure adhesive Transbond XT used for light curing in both APC brackets and non coated brackets is similar.. Both the bracket systems are cured using visible light curing unit of wavelength 440-470 NM. (***photogragh 1***) The time taken to bond APC bracket in 2 quadrants and non coated brackets in other 2 quadrants was recorded with a stop watch.

All patients were treated to a standard protocol. The aligning archwires used were 0.016 inch Nickel-Titanium arch wires followed by 0.019 x 0.025 inch Nickel-titanium rectangular wire for leveling. These were followed by 0.019 x 0.025 inch rectangular stainless steel archwires. Each subject was monitored for 3 months. Patients were seen at 4 weekly intervals, but were told to report to the department immediately if a bracket became loose.

If a bond failed the following were recorded.

1) Tooth number
2) Number of brackets failed in each patient
3) Site of bond failure based on ARI
4) Date of bond failure

Only the first bond failure was recorded, to eliminate any possible variation in the bond strength introduced from debonding which may have skewed the results.

Adhesive Remnant Index :[11]

Used to evaluate the amount of adhesive remaining on the tooth and the bracket base on bond failure**.**The ARI used was the one proposed by Artun and Bergland.

STATISTICAL ANALYSIS

All the data was analysed by using SPSS (Ver.13). Statistical factors for continuous values are presented as mean ± SD and categorical data by number and percentages. The difference between the groups as tested by student 't' test, Chi-square test, and Fisher's Exact test wherever appropriate A p value of 0.05 or less was considered for statistical significance.

RESULTS

Estimation of Bond Failure:

Of the 119 APC brackets bonded, 9 bond failures were recorded,. Of the 119 non-APC brackets bonded, 5 bond failures were recorded, as shown in (**Table 1).**

Evaluation of ARI Scores: Of the 5 non-APC bracket failures, 40% of debonds showed a score of 0 (no adhesive on tooth), other 40% scored 1 (little adhesive on tooth and most on bracket) with other 10% scoring 2 (half adhesive on tooth and half on bracket). With APC brackets, of the 9 failures, 44.4%showed a score of 0, 33.3%brackets showed score of 1 and 22.2% brackets showed score of 2. (**Table 2)**.

Evaluation of Time Interval of First Debond :

On the first day _ It showed that 57.14% of the total debonds failed on the first day i.e 8 out of 14 dedonds of which APC brackets had 6 debonds and non-APC brackets had 2 debonds. In **the first week** after bonding. APC brackets showed 1 bond failure where as non-APC showed 2 bond failures.

Other 2 bond failures out of 9 failures with APC brackets occurred at time interval of 15 days and 1 month respectively. But no bond failures were recorded with non APC brackets **(Table 3).**

After 2 months of bonding, only 1 bond failure with respect to non APC brackets was observed. No failures occurred upto 3 months of bonding in both the bracket systems.

Estimation of bonding time.

Time taken to bond each tooth was calculated by using formulae

$$\text{Time taken to bond each tooth} = \frac{\text{Time taken to bond 2 quadrants}}{\text{Total No. of Teeth present in 2 quadrants}}$$

The mean bracket bonding time per tooth per patient with APC was 134.9 seconds compared with non coated brackets it was 143.9 seconds. The mean difference between 2 bonding systems was 9 seconds. (**Table 4)**

DISCUSSION

Today, orthodontic attachments can be bonded successfully with a number of systems like chemical, photocured or dual cure as long as the inherent variables are controlled., but light cured adhesives are gaining more popularity every year for bracket placement because they offer benefits like : -

1) Extended working time to position brackets and clean up flash
2) Ability to place archwires immediately.[12]

This never ending quest of man to find a simple bonding procedure has continued and led to many innovations like self etching primers and adhesive precoated brackets to improve the speed and efficiency of bonding technique. 3M Unitek set the standard in orthodontic bonding efficiency with the introduction of APC brackets.

These brackets are pre-coated with a precise quantity of Transbond XT Photocurable adhesive on the bracket base, when it is desired to mount the bracket on a tooth, the bracket is simply removed from the package and placed directly onto the tooth surface.[13]

The bracket and adhesive are packaged in a container that protects the adhesive from light, evaporation, oxidation, contamination, humidity and sublimations. This tamper evident heat seal ensures a 3 year shelf-life. These precoated brackets come in an individual color coded well for easy identification and pre-oriented on a special foam liner that virtually eliminates bracket rotation in transit.[14]

In general, the adhesives used for adhesive precoated brackets that are received in a container or package having a release liner or coating that are more viscous than other available orthodontic bonding adhesives, in part to ensure that the adhesive retains its shape and does not separate or distort when the bracket is lifted from the package for use.[13] The adhesive used on the precoated bracket is similar in composition to that used in bonding uncoated brackets. The difference between the two adhesives are in the percentages of different ingredients incorporated rather than chemical composition. The purpose of adding more filler is to increase the viscosity, but this increased viscosity also increased the need to press the bracket on the tooth surface to squeeze the excess adhesive from under the bracket. As a result, the new modification APC II has been formulated to deliver a soft, pliable adhesive for easier bracket positioning. The percentages of APC II adhesive intergradient were identical to those in Transbond except for the curatives and other ingredients. A study done by Bishara SE, Ajloune R, Warren J (2002)[3] evaluated the effects of modifying the adhesive composition on the bond strength of orthodontic brackets using Transbond XT, APC, APC II and found that modifications introduced in the composite in order to facilitate orientation of bracket did not significantly affect the shear bond strength.

In the present study the time taken to bond APC brackets in 2 quadrants was comparatively less by 36.2 seconds when compared with non APC brackets. If all the 4 quadrants are considered, the time saved goes upto 72.4 seconds. This difference in bonding time obtained was statistically significant and clinically considerable. However, these results obtained were similar to Sunna S and Rock WP (1998)[1] who found reduced bonding time with APC brackets when compared with Transbond XT but was not statistically significant and contrast to Wong M and Power S (2002)[9] found increased bonding time with APC brackets but the result was not statistically significant.

Hence, it can be inferred that Adhesive precoated brackets represent a significant time saving for an orthodontic practice, because the adhesive need not be carefully applied on to the base of each bracket before placement of bracket on the tooth. In addition, the manufacturers can control the quantity of adhesive. So, that there is sufficient adhesive to substantially fill the space between the bracket and the tooth and yet there isn't an inordinate amount of adhesive that might otherwise require excessive peribracket clean up. In short, it has better handling characteristics

Bond failure rate in this study was evaluated In vivo because clinically, the bracket is exposed to repeated multidirectional forces that can cause fatigue failure. Clinical forces are continuous and intermittent for eg. Clenching, grinding and chewing .Also, temperature changes in oral environment caused by drinking hot or cold foods can cause expansion and contraction forces. (Kula et al, 2002).[15]

Further, bond failure rate was evaluated only in the first 3 months of treatment as Sonis and Snell (1989)[16] observed clinically that 90 percent of bracket failures occurred within the first three months following bracket placement, Wong M, Power S (2003)[9] found more than 70% of the failures for both APC and non APC brackets occurred in first 3 months. Ash and Hay (1996)[8] also recorded bond failures in first three months. Therefore, it was assumed that measuring bracket bond failures in the first 3 months gave a reasonable estimate of the long term performance of the APC and non APC brackets. Only first time bond failures was recorded, to eliminate any possible variation in the bond strength introduced from debonding which may have skewed the results. Kinch et al (1988)[4] found a less favourable rate with second and third time bonds compared to first time bond.

Overall (APC and non APC) bond failure rate over 3 months was found to be 5.88%, and specifically for APC it was 6.72% and for non-APC it was 5.04%. These results were in agreement with O'Brien et al (1989)[6] and Sonis (1989)[16] who found failure rates between 4.7–6.0% and 4.5–77% for various bracket adhesive combinations and also with Zachrisson (1985)[5] who recorded 7.9% of bond failure rate. Hence, it can be considered that the figures achieved in this study for both bracket systems were within the accepted range of clinical performance. Statistically no significant difference in bond failures between APC and Non-APC brackets was found in this study supports the finding of Sunna and Rock who detected no significant difference between APC and Non-APC over 1 year period in clinical performance and also were similar to results of Wong M and Power S (2004),[9] Kula, R. Schreiner, Brown J, Glaros A (2002)[15] that APC and non APC performed identically. Verstrynge A, Ghesquiere A, Williams G (2004)[7] registered similar bond failure rates for ceramic precoated and uncoated brackets.The distribution of ARI scores of debonded teeth seen in this study between the groups were similar, which is in accordance with Verstrynge A, Ghesquiere A, Williams G (2004)[7] and Sfondrini MF, Cacciafesta V, Klersy C (2002)[17] that there was no significant difference in distribution of ARI scores between 2 types of brackets. The use of adhesive precoated brackets is being promoted for use in indirect bonding. A modified Thomas indirect bonding technique for APC metal and ceramic brackets was clinically evaluated by Cooper RB and. Sorenson NA (1993) and recorded 1.4% bond failure rate which was considered to be favourable when compared with the 2-5% range found in most indirect bonding studies.[18]

CONCLUSION

The present study conclusively shows that APC brackets can be considered an efficient bonding system in orthodontics even though no significant difference was found in clinical performance of APC brackets over non precoated brackets because it eliminates a bonding variable i.e contamination of base. It has better handling properties, saves considerable chair side time, inventory control, is cost effective and also minimizes the need of assistance.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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