Bond strength of two techniques for bonding lingual orthodontic retainer

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هدفت هذه الدراسه الى مقارنة متانة الارتباط لطريقتين لتثبيت جهاز تقويم الأسنان اللساني، الطريقه المطوره، والطريقة التقليدية المستخدمه حاليا من قبل أطباء تقويم الأسنان. أجريت هذه الدراسة على ٦٤ سن ضاحك خالي من التسوس، وقد قسمت هذه العينه الى مجموعتين متساويتين: المجموعه (أ) وتمثل الطريقه التقليديه، والمجموعه (ب) وتمثل الطريقة المطوره. وتم قياس متانة الارتباط لكل مجموعه باستخدام جهاز الأنسترون. أجريت التحليلات الإحصائية لمقارنة البيانات المسجله لكل طريقه. وأوضحت نتائج هذه الدراسه أن الطريقة المطوره اظهرت قوة تحمل أعلى للقوه الضاغطه قبل فشل الرابطه المثبته مقارنة بالطريقه التقليديه (P = ٠,٠٢)، كما أظهرت الطريقه المطوره درجة أنحناء للسلك المثبت للتقويم قبل فشل الرابطة المثبته تفوق الطريقة التقليديه (P = ٠,٠٥). كما بينت نتائج هذه الدراسه أن الطريقة التقليدية اظهرت نسب ١٩٪، ٤٣,٥٪ و ٣٧,٥٪ للنوع الأول، الثاني والثالث من فشل الروابط على التوالي، بينا أظهرت الطريقه المطوره نسب ٦٩٪ ، ٦٪ و ٢٥٪ لنفس ترتيب أنواع فشل الروابط على التوالي. و يستنتج من هذه الدراسه أن الطريقه المطوره تميزت بمتانة ارتباط أعلى لمثبتات جهاز تقويم الأسنان اللساني مقارنة بالطريقه التقليديه. وتوصي هذه الدراسه باستخدام الطريقة المطوره لتثبيت جهاز تقويم الأسنان اللساني في مرحلة مابعد علاج تقويم الأسنان.

AIM: The aim of this study was to compare the shear bond strength of two techniques for bonding lingual orthodontic retainer; the chairside modified bonding technique introduced by Al-Emran and Hashim, and the chairside manual bonding technique currently used in orthodontic practice. **MATERIALS AND METHODS:** Sixty-four extracted caries-free premolars were divided into two equal groups. Group A represented the manual bonding technique and Group B represented the modified bonding technique. The shear bond strength was tested using the Instron™ machine. Descriptive statistical analysis and independent two-samples *t* test were employed to compare the data. **RESULTS:** The modified bonding technique (Group B) showed significantly higher tolerance to the applied load before the bond failure occurred (P=0.02). Also, Group B showed significantly higher degree of displacement of the bonded wire before bond failure (P= 0.05). Manual bonding technique (Group A) showed 19%, 43.5% and 37.5% of Types I, II and III bond failure respectively, whereas modified bonding technique (Group B) showed 69%, 6% and 25% of similar type of bond failure respectively. **CONCLUSIONS:** For the two bonding techniques examined in this study, the modified bonding technique showed higher shear bond strength compared to the manual bonding technique, and was recommended as a technique for bonding fixed lingual retainer for post-treatment retention phase.

INTRODUCTION

The use of orthodontic bonded retainer has less risk of demineralization of teeth surfaces with better aesthetics and patient acceptance.[1] A multi-stranded stainless steel wire, individually adjusted and bonded to each tooth in the desired arch segment remains the method mostly used for long-term retention. It is considered to be reliable, independent of patient compliance, highly effective, relatively easy to apply, almost invisible, and well accepted by patients. These are also the main advantages over removable retainers. However, damage to the bonded retainer is frequently observed in orthodontic clinic, which inevitably results in a loss of retainer function and, if ignored, may lead to a relapse.[2-4]

Bonded retainers of several types have been described in the orthodontic literature over the past years.[5] The first

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generation of mandibular bonded lingual 3-3 retainer used was a plain round Blue Elgiloy wire .032 to .036 inches with a loop at each end. Later, wires range from a prefabricated thick, round wire to a thin, flexible spiral wire.[6] The bonded retainer was often considered as long-term retention for orthodontic results. It has also been employed as a permanent splinting for periodontically compromised teeth. [7]

Stainless steel wires were used almost exclusively in both rigid and flexible forms, including different diameters, shapes, and plain or multi-stranded wires. Direct and indirect fabrication methods of lingual wire retainer have also been introduced in the literature.[8] However, bonding of an adjusted piece of wire to the lingual surface of the teeth is the most common technique currently employed in orthodontic practice. The retainer wire in this technique is often handled manually and bonded according to its best fit on the lingual surface of the teeth. More recently, Al-Emran and Hashim introduced the chairside modified bonding technique for lingual retainer.[9] They based their technique on a new method for holding the retainer wire against the lingual surface of the teeth prior to wire bonding the case.

The aim of this study was to compare the shear bond strength of lingual bonded retainer using the chairside modified bonding technique introduced by Al-Emran and Hashim[9] and the chairside manual technique currently used in the orthodontic practice.

MATERIAL AND METHODS

Sixty-four extracted caries-free premolars were stored in 10% formalin for a maximum of one week. All teeth were cleaned with a curette and 3% H_2O_2 as well as polished with pumice to remove debris and calculus. This was to obtain a clean, reproducible enamel surface. The sample was divided into two equal groups: Group A represented the manual bonding technique and Group B represented the modified bonding technique. Eight samples for each group were prepared. Each sample consisted of four premolars which were mounted in blue stone with proper contact points between the crowns of the teeth.

The fabrication and bonding technique of the lingual wire retainer for Group A was as follows:

1. Three strands of .010" stainless steel ligature wire were held together at both ends with mosquito forceps and twisted into a single wire followed by bending the wire into a gentle curve.
2. The wire retainer was then cut to the desired length of the four premolars.
3. The lingual surfaces of the premolars were acid-etched with 37% phosphoric acid for 45 seconds, then rinsed and air-dried until the surfaces appeared chalky.
4. A light-cured bonding agent was applied to the lingual surfaces and activated with a light source.
5. The light-cured composite (Transbond™)* was added to the teeth surfaces. Equal amounts of the composite were used for bonding to each tooth using a plastic tip in a dispensing gun.
6. The lingual wire retainer was then placed manually in position and pressed against the teeth surfaces into the composite according to wire best fit.
7. Each tooth was light-cured for 40 seconds to achieve a final set of the composite.

The fabrication and bonding technique of the lingual wire retainer for Group B was performed as described by Al-Emran and Hashim.[9] After the buccal surfaces

* 3M Unitek, 2724 South Peck Rd., Monrovia, CA 91016, USA

of the teeth were bonded with .022" steel brackets at the height of 4 mm from the buccal cusp tip, using bracket height gauge .016 x .022 SS archwires were fitted and ligated with elastic ties to represent the pre-debonding treatment phase and the following steps were carried out:

1. Three strands of .010" stainless steel ligature wire were held together at both ends with mosquito forceps and twisted into a single wire followed by bending into a gentle curve.
2. The lingual wire retainer was cut to the desired length of the four premolars.
3. Three to four centimeters-long strands of stainless steel ligature wire 0.010" were passed below the archwire through the contact points between the premolars.
4. The lingual wire retainer was then held against the lingual surfaces of the premolars and tighten by the three pieces of the ligature wires.
5. The lingual surface of the teeth together with the wire on was acid-etched with 37% phosphoric acid for 45 seconds, rinsed and air-dried until the surface appeared chalky.
6. A light-cured bonding agent was applied to the lingual surfaces and the wire, then activated with a light source.
7. Light-cured composite (Transbond™) was added to the retainer wire and teeth surfaces. Each tooth was light-cured for 40 seconds to achieve a final set of the composite.

The shear bond strength in Newton (N) and the maximum displacement in (mm) of the bonded retainer were measured using the Instron™** machine. The load was applied vertically to the center of the wire between the two teeth in the middle using a speed load of 2.54 mm/min. The load was applied on the retainer wire until bond failure occurred, a printout graph that indicated the maximum wire displacement and the amount of load applied before bond failure was produced for each sample using a designed software. The two premolars in the middle of each sample were selected for scanning electron microscope (SEM) examination to determine the type of bond failure that had occurred. The bond failure sites were classified into three types namely Type I: Tooth / Resin interface, Type II: Wire / Resin interface, Type III: Combined failure of Types I and II.

The data were entered into the computer using Statistical Package for the Social Science (SPSS version 10). Statistical analysis was done using the same package. Descriptive statistical analysis and independent two-samples t test were employed to compare the data of the two techniques. Significance level was set at 5%.

RESULTS

The results of this investigation revealed that after using the independent two- samples t test, a significant difference between the two techniques regarding the amount of load the bonded lingual wire retainer was able to tolerate before bond failure occurred ($P < 0.05$). Group A (manual bonding technique) showed less tolerance to the load applied than Group B (modified bonding technique). When the maximum displacement of the bonded lingual retainer before bond failure was compared in the two groups, samples in Group B showed significantly higher displacement than samples in Group A ($P=0.05$) as shown in Table 1.

The results of scanning electron microscope (SEM) examination revealed the following: in Group A: 19 % (n=3) of the teeth had Type I failure, 43.5 % (n=7) of the teeth had Type II failure, and 37.5 % (n=6) of teeth had Type III failure. In Group B: 69 % (n=11) of the teeth had Type I failure, 6 % (n=1) of the teeth had

** Instron Corp., 100 Royall St., Canton, MA 02021, USA

Type II failure, and 25% (n=4) of the teeth had Type III failure (Table 2). Scanning electron micrographs of the three types of bond failure are shown in Figure 1.

Table 1. Mean and standard deviation (SD) of the load in Newton (N) and maximum displacement (Max. Disp.) in mm of the two groups.

	Group A		Group B		Independent two-samples *t* test (*P* value)
	Mean	SD	Mean	SD	
Load (N)	41.7	18.7	72.6	28.5	0.02
Max. Disp. (mm)	1.2	0.4	1.8	0.6	0.05

Table 2. Percentage of different types of bond failure in the two groups.

	Type I		Type II		Type III	
	n	%	n	%	n	%
Group A	3	19	7	43.5	6	37.5
Group B	11	69	1	6	4	25

DISCUSSION

From a clinical point of view, the need for secure retention after orthodontic treatment is unquestioned. However, various methods have been proposed for retaining the lower labial segment after orthodontic therapy.[2] One of the most popular is the 3-3 bonded lingual retainer. Such a retainer can be fabricated and bonded using different techniques. Whatever the technique used, the key factor in successful lingual orthodontic retainer remains the accurate placement, adaptation and immobilization of the wire during bonding procedure. [8,10-12]

This study showed high load tolerance of the bonded lingual wire retainer using Al-Emran and Hashim[9] modified bonding technique. This can be explained by the close approximation and adaptation of the retainer wire to the teeth surfaces. In addition, the bonding procedure of the modified technique allowed both the wire retainer and the teeth surfaces to be

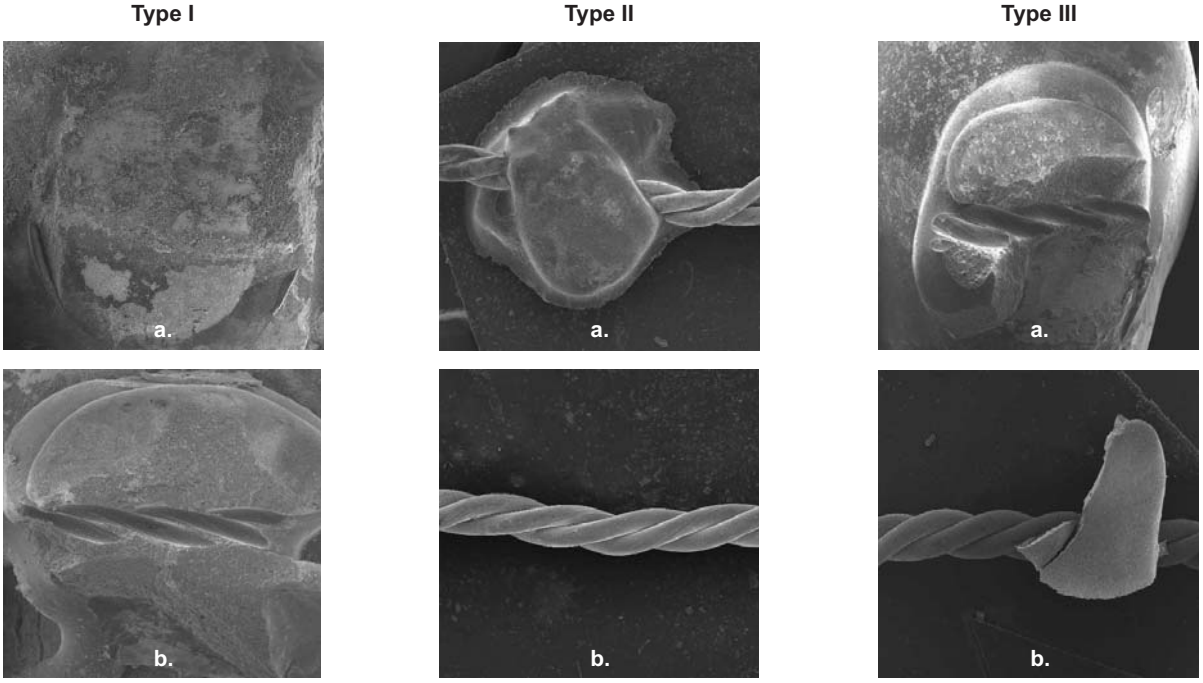

Fig. 1. Scanning electron micrograph (magnification 12x) of Type I, Type II and Type III bond failures (a) tooth surface and (b) lingual wire retainer.

acid-etched and the bonding materials to be applied on them together. Whereas, in the manual bonding technique the wire retainer was handled manually in position and pressed against the teeth surfaces into the bonding composite according to the estimated wire's best fit. A chance of different degrees of adaptation on teeth surfaces might have occurred in this technique.

Bearn[13] reported that the weakest point of the bond is the composite/wire interface. However, composite/tooth interface, and combined composite/ tooth/wire type of failure have previously been reported.[2] In this study, the scanning electron microscope revealed that samples in Group A showed more of Type II (Wire / Resin interface) than Type I (Tooth / Resin interface) bond failure compared to the samples in Group B. This might be due to the poor adaptation of the lingual wire retainer to teeth surfaces and the chance of having air bubbles in Group A samples compared to Group B samples.

CONCLUSIONS

1. The modified bonding technique showed higher shear bond strength and maximum displacement of the lingual retainer than the manual bonding technique.
2. The chairside modified bonding technique showed more of Type I (69%) of bond failure compared to Type II (43.5%) of bond failure in the manual bonding technique.

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REFERENCES

1. Lee R. The lower incisor bonded retainer in clinical practice: A three year study. Br J Orthod 1981; 8:15-18.
2. Radlanski R, Zain N. Stability of the bonded lingual wire retainer: A study of the initial bond strength. J Orofac Orthop 2004; 4: 321-335.
3. Orsborn K. Bonded lingual retainers. Am J Orthod 1983; 83: 218-220.
4. Wasserstein A, Brezniak N. Use of disclosing material to detect fixed retainer bond failures. J Clin Orthod 1998; 32: 598-599.
5. Liou E, Chen L, Huang S. Nickel-titanium mandibular bonded lingual 3-3 retainer for permanent retention and solving relapse of mandibular anterior crowding. Am J Orthod 2001;119: 443-449.
6. Zachirsson B. Third generation mandibular bonded lingual 3-3 retainer. J Clin Orthod 1995; 28: 39-48.
7. Becker A, Goultschin J. The multistrand retainer and splint. Am J Orthod 1984; 6: 470-474.
8. Rossouw P, Joseph V. Indirect fabrication of a bonded lower lingual retainer. J Clin Orthod 1992; 26: 413-415.
9. Al-Emran S, Hashim H. A chairside bonded lingual retainer. J Clin Orthod 1997; 6: 358-360.
10. Zachrisson B. The bonded lingual retainer and multiple spacing of anterior teeth. J Clin Orthod 1983; 12: 838-844.
11. Eade P. Modified direct bond lingual retainer technique. Br J Orthod 1980; 7: 125-126.
12. Orchin J. Permanent lingual bonded retainer. J Clin Orthod 1990; 24: 229-231.
13. Bearn D. Bonded orthodontic retainers: A review. Am J Orthod Dentofacial Orthop 1995; 108: 207-213.