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ORIGINAL RESEARCH

Failure Rates of Orthodontic Fixed Lingual Retainers bonded with Two Flowable Light-cured Adhesives: A Comparative Prospective Clinical Trial

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ABSTRACT

Introduction: This comparative prospective randomized clinical trial examined the *in vivo* failure rates of fixed mandibular and maxillary lingual retainers bonded with two light-cured flowable composites over 6 months.

Materials and methods: Consecutive patients were divided into two groups on a 1:1 basis. Two hundred fixed lingual retainers were included, and their failures were followed for 6 months. One group (n = 50) received retainers bonded with a nano-hybrid composite based on nano-optimized technology (Tetric-N-Flow, Ivoclar Vivadent). Another group (n = 50) received retainers bonded with a low viscosity (LV) composite (Transbond Supreme LV, 3M Unitek).

Results: There was no significant difference between the overall failure rates of mandibular retainers bonded with Transbond (8%) and those bonded with Tetric-N-Flow (18%). However, the odds ratio for failure using Tetric-N-flow was 2.52-fold greater than that of Transbond. The failure rate of maxillary retainers bonded with Transbond was higher (14%), but not significantly different, than that of maxillary retainers bonded with Tetric-N-flow (10%). There was no significant difference in the estimated mean survival times of the maxillary and mandibular retainers bonded with the two composites.

Conclusion: Both types of composites tested in the current study can be used to bond fixed maxillary and mandibular lingual retainers, with low failure rates.

Keywords: Failure rates, Flowable composite, Orthodontic fixed retainers.

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INTRODUCTION

Retention is an integral part of orthodontic treatment. It helps prevent the tendency for unwanted relapse of teeth toward their original position. There are two basic common designs for fixed lingual retainers: A rigid wire bonded to the canines only, which is used mainly on the mandibular teeth, and a fixed spiral wire, i.e., bonded to every single tooth, from canine to canine. The latter is useful in preventing individual tooth rotation or spacing relapse.[1-3] Failures of fixed lingual retainers can be classified based on their extent (i.e., partial or complete failures), or they can be classified based on the type of failure (i.e., a failure at the tooth–adhesive interface, failure at the adhesive–wire interface, or a breakage within the wire).[4]

Previously studied factors influencing the *in vivo* stability or survival of fixed retainers include the type of wire used,[5-8] polymerization method of the adhesive used,[9] technique of applying the retainer (direct *vs* indirect),[10-12] method of isolation or type of adhesive used,[13] and the use of liquid resin during the bonding procedure.[14] Factors, such as patient gender and age and the operators' years of experience have been found not to be significant.[11] It has been shown that the first 6 months after the attachment of fixed lingual retainers is the most critical time, with most of the failures occurring during this period.[12]

Other *in vitro* studies have examined additional factors that might impact the survival of fixed lingual retainers, such as the light-curing instrument used,[14] the adhesive surface area,[15] or the use of self-adhering composites with or without acid etching.[16] The aim of this comparative prospective randomized clinical trial was to examine the *in vivo* failure rates of fixed mandibular and maxillary

lingual retainers bonded with a light-cured nano-hybrid composite based on nano-optimized technology and a light-cured low viscosity (LV) flowable composite over a 6-month period.

MATERIALS AND METHODS

The sample consisted of 100 consecutive patients divided into two groups on a 1:1 basis. The first group of 50 patients (37 females and 13 males, mean age: 21.4 ± 5.3 years) received fixed canine-to-canine mandibular and maxillary lingual retainers following the completion of their orthodontic treatment that were bonded with a light-cured nano-hybrid composite based on nano-optimized technology (Tetric-N-Flow, Ivoclar Vivadent, Schaan, Liechtenstein). The second group of 50 patients (30 females and 20 males, mean age: 20.48 years) received fixed canine-to-canine mandibular and maxillary lingual retainers that were bonded with a light-cured LV composite (Transbond Supreme LV, 3M Unitek, Monrovia, California, USA). Both types of composites are characterized as flowable composites but are produced based on different manufacturing methods. The fixed spiral lingual retainers were fabricated according to the method described by Al Emran and Hashim.[17] The advantages of this retainer are its ease of chair-side fabrication and the fact that it is flexible enough to be adapted to the lingual surfaces of the maxillary and mandibular incisors.[17] Prior to the debonding of the fixed orthodontic appliances, the lingual surfaces of the incisors and canines were inspected and cleaned using oil-free pumice. The lingual retainers were bonded directly to the lingual surfaces of the incisors and canines. The enamel surface was prepared using 35% phosphoric acid (Ivoclar Vivadent, Amherst, New York, USA) for 20 seconds. Then, the enamel surfaces were rinsed and dried. The flowable composites were dispensed directly on the fixed retainer and the lingual surfaces of the teeth and then light-cured for 3 seconds per tooth on each side using an Ortholux LED light-curing unit (3M Unitek). Then, the composite was finished using a flame-shaped composite-finishing bur.[2] Thereafter, the fixed orthodontic appliance was debonded. Then, the patients were given standardized oral hygiene instructions and were informed to come to the clinic if the retainer failed. Patients were followed for 6 months. Failures were recorded as partial or complete. Once the patient reported to the clinic with a failure, the retainer was rebonded and was not included any further in the study.

All patients signed an informed consent and had no objection to being included in the study. The inclusion criteria were as follows: All patients required comprehensive orthodontic treatment and had no missing canines or incisors, no signs of caries or fillings on the lingual surfaces of the teeth, no history of previous orthodontic treatment, and no history of receiving any type of retention devices. All lingual retainers were bonded by the same operator to standardize the method.

Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) Inc., Chicago, IL, USA. Mean survival time in days, standard deviations, and standard errors were calculated. In addition, odds ratios and 95% confidence interval (CI) for the failure of the fixed maxillary and mandibular lingual retainers were calculated. A comparison of the survival rates for both mandibular and maxillary retainers was carried out using Kaplan-Meier test. The level of significance was set at $p < 0.05$.

RESULTS

A total of 200 lingual fixed retainers (100 maxillary and 100 mandibular) were included in this prospective clinical trial, and their failure was followed for a period of 6 months. There was no statistically significant difference between the overall incidence of failure of fixed mandibular lingual retainers bonded with Transbond LV (8%) and the failure rate of fixed mandibular lingual retainers bonded with Tetric-N-Flow (18%). However, the odds ratio for failure was 2.52-fold greater when using Tetric-N-flow than when using Transbond LV (Table 1).

The failure rate of maxillary lingual retainers bonded with Transbond LV was higher (14%) than that of those bonded with Tetric-N-flow (10%). However, the difference was statistically insignificant. The odds ratio of failure for maxillary lingual retainers bonded with Transbond

Table 1: Incidence of failure of maxillary and mandibular lingual fixed retainers and comparison of odds ratio and 95% CI with lower and upper bounds

Type of failure / *Type of composite*	*Transbond LV*	*Tetric-N-flow*	*Odds ratio*	*95% confidence interval*	
				LB	*UB*
Incidence of failure of mandibular fixed retainers	8%	18%	2.52	0.723	8.82
Incidence of complete failure of mandibular fixed retainers	4%	Zero			
Incidence of partial failure of mandibular fixed retainers	4%	18%	5.4	1.102	26.443
Incidence of failure of maxillary fixed retainers	14%	10%	1.46	0.201	2.315
Incidence of complete failure of maxillary fixed retainers	8%	Zero			
Incidence of partial failure of maxillary fixed retainers	6%	10%	1.74	0.392	7.713

Table 2: The estimated means and standard deviations of the survival time of the mandibular fixed retainers using two types of composites

Type of composite	Mean ± SD days	Standard error	95% confidence interval		p-value
			Lower bound	Upper bound	
Transbond LV	172.20 ± 31.3	4.34	163.6	180	0.126
Tetric-N-flow	155.04 ±54.6	7.64	140.05	170.02	

LV was 1.46. Approximately 50% of failures occurring with Transbond LV were complete failures, whereas no complete failures occurred when using Tetric-N-flow. The partial failure rate of fixed mandibular lingual retainers was significantly greater when using Tetric-N-flow (18%) than when using Transbond LV (4%), with an odds ratio for Tetric N-flow of 5.4 and a 95% CI of 1.102 to 26.4, excluding 1 (Table 1).

The estimated mean survival time of the fixed mandibular retainers bonded with Transbond LV was 172.2 ± 31.3 days, and it was 155.04 ± 54.6 days for those bonded with Tetric-N-flow. A Kaplan-Meir test showed no significant difference between the two groups (p = 0.126) (Table 2, Graph 1). In addition, there was no significant difference (p = 0.594) between the estimated mean survival time of fixed maxillary retainers bonded with Transbond LV (170.36 ± 29.9) and those bonded with Tetric-N-flow (166.68 ± 41.7 days) (Table 3, Graph 2).

Table 3: The estimated means and standard deviations of survival time of the maxillary fixed retainers using two types of composites

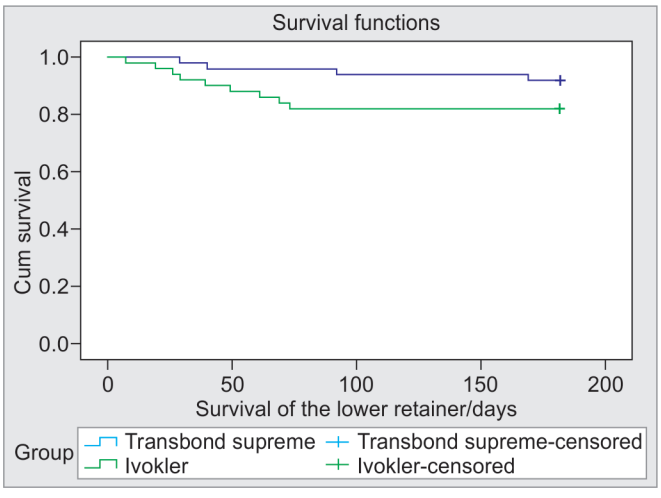
Type of composite	Mean ± SD days	Standard error	95% confidence interval		p-value
			Lower bound	Upper bound	
Transbond LV	170.36 ± 29.9	4.15	162.2	178.4	0.594
Tetric N-flow	166.68 ± 41.7	5.8	155.2	178.1	

DISCUSSION

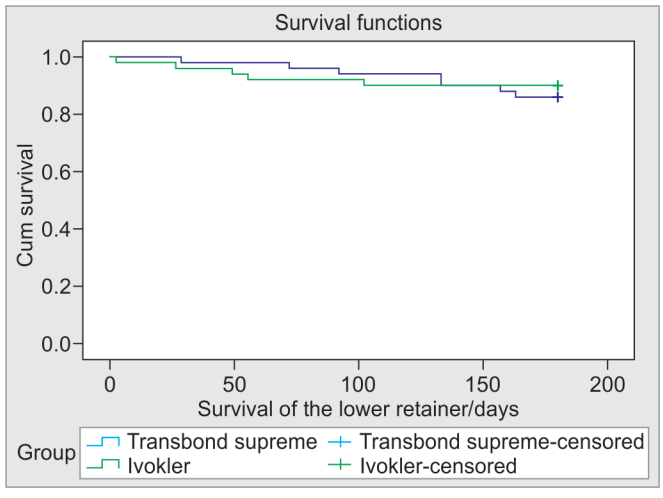
Using fixed lingual retainers to maintain the results achieved with orthodontic treatment is a common procedure. The greatest advantage of using this type of retainer is that no patient compliance is required, unlike with removable retainers. The main disadvantage is the risk for breakage and failure of these retainers. Previous clinical studies have examined different variables in attempts to enhance the survival of these retainers. These variables include using different types of wires,[5-8] using chemically cured *vs* light-cured adhesives,[9] and the technique used for placing these retainers.[10-12] Most of these prospective studies used an observation period of 6 months because this is the most critical period for such failures.[12]

According to the manufacturer's claims, the flowable composites used in this study contain nano-fillers that enhance their bond strength, flow, and wear properties, when subjected to masticatory forces and different oral environments. According to our knowledge no previous studies have examined the clinical performance of these composites when used for the adhesion of fixed lingual retainers.

The failure rate for these fixed retainers using a direct method and a conventional composite (Transbond LR, 3M Unitek) was reported to be 46.9% at the end of a 6-month prospective observation period.[10] The current study shows that the failure rate for both mandibular and maxillary fixed lingual retainers was lower when using either type of flowable composite than when using conventional composites. The failure rate for fixed mandibular retainers was 8% using Transbond LV and



Graph 1: A line graph showing the difference of survival of the mandibular fixed lingual retainers bonded with two types of adhesives



Graph 2: A line graph showing the difference of survival of the maxillary fixed lingual retainers bonded with two types of adhesives

18% using Tetric-N-flow, while the failure rate for fixed maxillary retainers was 14% using Transbond LV and 10% using Tetric-N-flow. These lower failure rates may be attributed to the clinical handling properties and LV of these flowable composites compared with the properties of conventional composites. There were no overall differences in the failure or survival rates between the two types of composites tested here. A previous study reported that the detachment rate for fixed mandibular multistranded steel retainers similar to the ones used in this study was 15.62% after a 6-year retention period.[7] These results are in agreement with the failure rates observed (18%) using Tetric-N-Flow after a 6 months retention period. The failure rate of fixed maxillary multistranded steel retainers was 21.42%,[7] which is higher than the rate observed in the current study. This may be attributed to the longer observation period or to the nature of fixed maxillary retainers, which are prone to failures due to masticatory demands, the difficulty in achieving proper placement of these retainers and their accessibility for finishing the composite holding the retainer.

Failure of fixed lingual retainers can be classified as either partial or complete. Partial failure is characterized by the loss of attachment from one or more teeth, whereas complete failure is characterized by the total detachment of the fixed retainer from the teeth. From a clinical perspective, complete failure is more desirable than partial failure because partial failure can go unnoticed by the patient and may result in the relapse of the teeth toward their pretreatment condition. The partial failure rate for fixed mandibular retainers was significantly higher when using Tetric-N-flow, while 50% of the failures occurring with Transbond LV were complete failures. This may help orthodontist in determining the selection criteria for the flowable composites to be used in their practice.

The Transbond LV flowable composite is primarily designed by the manufacturer to be used for the indirect bonding of orthodontic brackets. However, this study shows that this type of flowable composite can be used for bonding fixed lingual retainers in both the mandible and the maxilla, with a relatively low failure rates over 6 months. The LV of these newly developed composites improves their clinical and handling properties. In addition, the nano-fillers present within the adhesive provide a mechanical advantage when using them for bonding fixed lingual retainers.

The findings of the current study are promising and should encourage manufacturers to improve the mechanical, handling, and clinical properties of adhesives used for bonding fixed lingual retainers to reduce failures rates over the long retention periods needed to prevent short- and long-term relapses of orthodontically treated malocclusions.

CONCLUSION

Both flowable composites, each with nano-fillers, tested in the current study can be used for the bonding of fixed maxillary and mandibular lingual retainers, with low failure rates. Bonding fixed lingual retainers with Transbond LV resulted in a higher rate of complete failures than the use of Tetric-N-flow. This may be considered an advantage rather than a drawback, as it would reduce the occurrence of unnoticed partial failures of these fixed retainers.

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