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Comparison Of Shear Bond Strength Of Lingual Retainer Wire Bonded With Conventional Orthodontic Composite And Nano-Ceramic Flowable Composite: An In-Vitro Study.

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Abstract:
This study was conducted to compare the shear bond strength of lingual retainer wire bonded with conventional orthodontic composite (Enlight,Ormco) and nano-ceramic flowable composite (Tetric N-Flow,Ivoclar.)
Materials and Methods: *Sixty pairs of extracted human incisor teeth were collected, stored and divided into two groups of 30 pairs each. The teeth samples were mounted on acrylic blocks and the coaxial stainless steel lingual retainer wire of 7mm length was bonded with conventional orthodontic composite (Enlight,Ormco) in Group I and nano-ceramic flowable composite (Tetric N-Flow,Ivoclar.) in Group II, as per manufacturer's protocol. The composite used to bond retainer wire was restricted to 2mm in diameter on each tooth in both the groups. The shear bond strength was measured using Universal testing machine with the crosshead speed of 1.25mm/min and the data obtained was statistically analyzed using Unpaired 't' test.*
Results: *The mean value of the shear bond strength of lingual retainer wire bonded with conventional orthodontic composite (Enlight, Ormco) was 88.37 ± 15.2 Newton (N) whereas the group of lingual retainer wire bonded with nano hybrid flowable composite (Tetric N-Flow,Ivoclar) showed the mean shear bond strength of 106.5 ± 13.5 N. The data analyzed using Unpaired 't' test revealed statistically significant difference within the groups.*
Conclusion: *This study concluded that the shear bond strength of lingual retainer wire bonded with nano-ceramic flowable composite is higher than the shear bond strength of conventional orthodontic composite. This result could potentially be due to lower viscosity of nano hybrid composite as compared to the conventional orthodontic composite which makes it easier to flow.*
Key Word*: Lingual retainer, Bond Strength, Enlight Ormco, Tetric N-Flow Ivoclar*.

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I. Introduction

Tooth movement due to the persisting imbalance of operating forces is a major problem after orthodontic treatment. [1] Stabilization of orthodontic treatment outcomes is necessary to ensure the success of such treatments and to prevent teeth from moving back into their former position. After every orthodontic treatment, retention is essential to maintain therapy outcomes and to avoid relapse. [2]

Bonded lingual retainers have become increasing popular as method of retention since the late 1970s, particularly in the mandibular incisor area. [3] Gottlieb et al [4] reported that 81% of surveyed orthodontists use bonded lingual retainers, of which 37% use them routinely and 44% on occasion.

Despite the available reports regarding the acceptable survival of lingual retainers, fracture of the retainers and their adhesive debonding from the tooth surface are still among the most common types of clinical failures. [5] The material and structure of the retainer, type of composite resin used for bonding of the retainer, and the position of the retainer (maxilla or mandible) are among the most influential factors affecting the survival and success of lingual retainers. [6]

Buonocore [7] introduced the technology that eventually leads to the concept of direct bonding in orthodontics.

Orthodontic adhesives have evolved from the epoxy resins that were first used by G. V. Newman in 1965.[8] As an organic material, BisGMA developed by Bowen in 1956 revealed high viscosity due to hydrogen bonding interactions.[9]

BisGMA is diluted with a more fluid resin, that is, triethylene glycol dimethacrylate for orthodontic use. Urethane dimethacrylate offers lower viscosity, more effective light curing, lower water sorption, greater toughness than BisGMA. The bond strength of UDMA adhesives depends on the filler content. [10]

Flowable resin composites have been recommended for many clinical uses and have been formulated in a variety of compositions and viscosities to meet various uses. [11] A plethora of new low-viscosity composite resin materials, or flowable composites, have been marketed during the past three years.

While various types of composites such as microfilled, microhybrid and flowable are available, the latest development in this field has been the introduction of nano-filled composites that are claimed to achieve higher wear resistance and appropriate mechanical properties. [12] They also enhance the hybrid layer, increase marginal seal and reduce polymerization shrinkage due to their higher filler content. Furthermore, nano-filler bonding have shown satisfactory bond strength to enamel and dentin, and can be utilized for direct and indirect restorations. [13, 14] Therefore, it is likely that nano-filled composites may replace other types of composites in the near future.

Despite the extensive applications of nano-composites in restorative dentistry, there is inadequate data regarding the advantages of nano filled over conventional composite for the bonding of lingual retainer wire.

The aim of this in‑vitro study, therefore, is to assess the shear bond strength (SBS) of lingual retainer wire bonded with the conventional orthodontic adhesives and nano‑filled flowable adhesives.

II. Material and Methods

This prospective comparative study was carried out in-vitro in Department of Orthodontics at Geetanjali Dental and Research Institute, Udaipur, Rajasthan. A total 60 extracted maxillary and mandibular incisors were collected and divided into two groups of 30 pairs each.

Study Design: Prospective observational study
Study Location: This was a tertiary care teaching hospital based study done in Department of Orthodontics, at Geetanjali Dental and Research Institute, Udaipur, Rajasthan.
Study Duration: November 2021 to May 2022.
Sample size: 60 incisors.
Sample size calculation:
Subjects & selection method:

Inclusion criteria:
1. Intact lingual tooth surface.
2. Maxillary or mandibular incisors.
3. Unattrited, uncracked
4. No exposure to any chemicals
5. Free from any hypoplastic areas.

Exclusion criteria:
1. Gross irregularities
2. Fractured tooth
3. Chemically treated teeth
4. Hypoplastic tooth surface
5. Attrited or cracked tooth

Procedure methodology

Sample teeth were scaled and polished with pumice and stored in normal saline at 37°C for no longer than three months. Each tooth was then placed in a mold and embedded in self‑curing acrylic resin (Fig.1). Stainless steel 0.0175 inch co-axial lingual retainer wire of 7 mm in length was taken.

Figure:1

Bonding procedure

Group I: Lingual retainer wire bonded with conventional orthodontic composite resin, Enlight, Ormco. (Fig.2)

Figure. 2

Figure:3

The lingual enamel surface was etched with 37% phosphoric acid for 30 seconds, rinsed for 15 seconds, and dried with oil and moisture‑free air until the enamel had a faint white appearance. Ortho Solo primer was applied as a thin film to the etched surface and light‑cured for 10 seconds. Enlight, Ormco adhesive paste was applied to the stainless steel coaxial lingual retainer wire and the wire was positioned on the tooth and light‑cured as per the manufacturer's protocol.
A diameter of 2mm of the adhesive, on each tooth was maintained in all the samples.
Group II: Lingual retainer wire is bonded with nanoceramic composite resin, Tetric N-Flow, Ivoclar.
This adhesive paste was applied to the lingual retainer wire, and the wire was positioned on the etched and primed lingual surface and light‑cured for 10 seconds according to the manufacturer's protocol (Fig. 3).
A diameter of 2mm of the adhesive, on each tooth was maintained in all the samples.

Debonding procedure

The shear bond strength of the adhesive was measured using Universal Testing Machine at a cross head speed of 1.25 mm/minute. A custom‑made rod was locally fabricated for exerting a force parallel to the tooth surface in an occlusal‑apical direction in between both the teeth of each sample (Fig 4). The force applied at failure was recorded in Newtons (N).

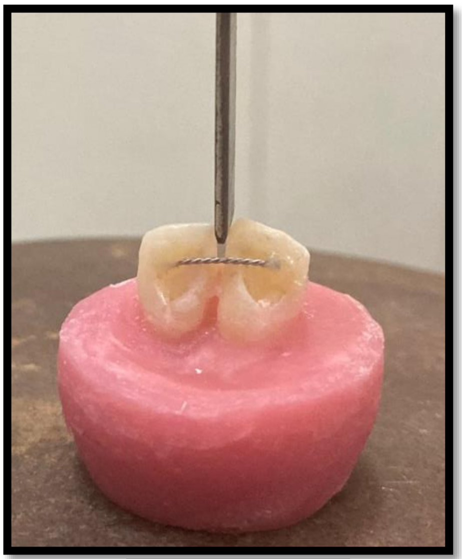


Figure: 4

Statistical analysis

Descriptive statistics including the mean, standard deviation, and minimum and maximum values were calculated for each of the various groups of teeth tested.
Unpaired "T" test was used to determine whether significant differences existed between the two groups of the bond strength values calculated. Significance for all statistical tests was predetermined at $P \leq 0.001$.

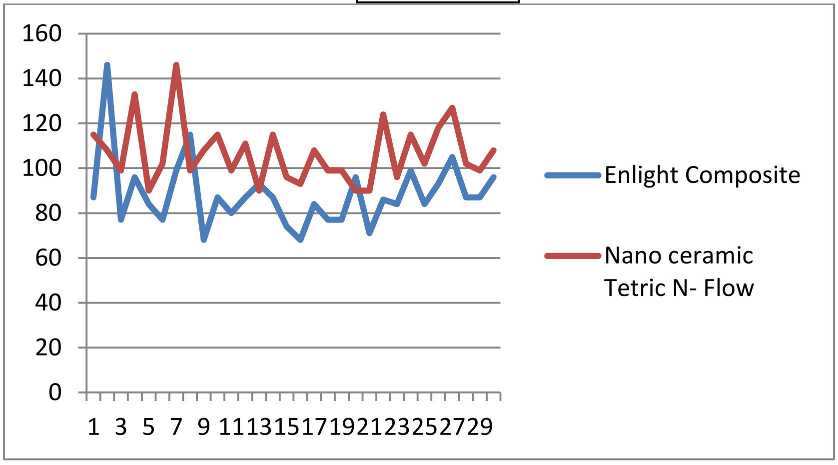
III. Results

The descriptive statistics, including the mean, standard deviation, range, minimum and maximum values of shear bond strength for each of the two groups are presented in Table 1 and the shear bond strength values of both the groups are shown in Graph 1.

TABLE 1.

MATERIALS	N	MEAN	STANDARD DEVIATION	RANGE	MINIMUM	MAXIMUM
GroupI Enlight, Ormco	30	88.3N	15.2	78	68	146
Group II Tetric N-Flow, Ivoclar	30	106.5	13.5	56	90	146

GRAPH 1



IV. Discussion

Retention is mandatory following orthodontic treatment to prevent relapse. Several factors are involved in the occurrence of relapse following completion of orthodontic treatment such as the abnormal function of the muscles, occlusal stresses, and regeneration of periodontal fibers. [15] Thus, it appears that the use of fixed lingual retainers is the only way to maintain the ideal alignment of the teeth following completion of orthodontic treatment. [16] Long-term studies have confirmed that lingual retainers can effectively maintain the new position of mandibular incisors following orthodontic treatment. Use of lingual retainers is even more important when the inter-canine width needs to be maintained after treatment and also when the supporting periodontal tissue is lost. [17]

Most bonding studies use commercially available adhesive systems that have different filler particle sizes, viscosities, and concentrations. This makes comparison among the groups difficult because of the increased number of variables involved in the adhesive composition. [18]

Flowable composites are low viscosity composite resins, created by retaining the same particle size of traditional hybrid composites, but reducing filler content and increasing resin content to reduce viscosity of resin. Flowable composites were marketed for bonding of brackets during early 21st century. Flowable composite merits special attention because of their clinical handling, characters of nonstickiness, fluid injectability and shear bond strength comparable to that of traditional composite adhesives. [19]

Hence, this study was conducted to assess the shear bond strength (SBS) of lingual retainer wire bonded with the conventional orthodontic adhesives and nano‑filled flowable adhesives.

Hobson et al [20] recommended using incisors instead of human molars and premolars, because they found a significant difference of shear bond strength between different tooth types.

Comparison of shear bond strength of Enlight, Ormco with Tetric N-Flow Nanofilled Flowable Ceramic.

The mean bond strength for the conventional orthodontic composite Enlight, Ormco was 88.3 N ±15.2 which was recorded higher than the values obtained in the study conducted by **Golshah A and Amiri Simkooei Z** [21] which showed the mean shear bond strength of 55.9 ± 23.13 N.

Reynolds [22] stated that the minimum bond strength of 5.9–7.9 MPa could result in successful clinical bonding. In this study, both the adhesives had higher bond strength than stated by Reynolds. The studies done by Reynolds were *in vivo*, hence making the exact comparison difficult due to the difference in clinical conditions. *In‑ vitro* studies are not subjected to the rigorous oral environment, same humidity level, and heat conditions.

The study conducted by **Al-Nimri K and Al-Nimri J** [23] has obtained a similar result in which the co-axial lingual retainer wire bonded with nanofilled flowable composite showed a higher mean shear bond strength of 158.2 N ± 3.8 than that of a conventional orthodontic composite of 126.2 N ± 4.3. Though the values obtained were higher than our study which may be due to difference in evaluation procedure.

Another study conducted by **Chalipa J et al** [24] has obtained similar results, concluding higher shear bond strength of nano composite while bonding an orthodontic bracket, as compared to the shear bond strength of a conventional orthodontic composite. There was no significant difference in the values obtained when compared to this study.

In another study conducted by **Tabrizi S et al** [25] on different wire/composite combinations, it was concluded that Tetric Flow, a flowable restoration resin, should be preferred as a bonding composite as it demonstrated better initial bonding values, possibly due to its elasticity.

Hence it can be concluded that nano filled composite is a better option for bonding lingual retainer wire. However, the values obtained for conventional orthodontic composite also exceeds the minimal acceptable strength required for orthodontic bonding. Therefore, conventional orthodontic composite could also be a choice for bonding lingual retainer wire if supplied in a lower viscosity by the manufacturer.

V. Conclusion

From the results of this study, the following conclusions can be drawn:

- The nano filled flowable composite showed a higher shear bond strength value, hence it can effectively be used for bonding lingual retainer wire.
- Conventional orthodontic composite (Enlight, Ormco) showed a lesser mean shear bond strength when compared to nano-filled flowable composite (Tetric N- Flow), with statistically significant difference. However, the mean shear bond of Enlight,Ormco was within the clinically acceptable range for bonding lingual retainer wire.
- Therefore, it may be suggested that, for bonding purpose of lingual retainer wire, the manufacturer could consider formulating the composition of Enlight, Ormco, to produce a material with lower viscosity that can increase the flow and the ease of handling in the lingual region.
- This study evaluated the shear bond strength of a conventional orthodontic composite and a nano filled flowable composite. However, there is a future scope for evaluating the properties of newly introduced materials for bonding in orthodontics.

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