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Original Research

Influence of Self-Etch Universal Adhesive on Micro Tensile Bond Strength of Dentin Treated with Various Irrigants

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ABSTRACT:

Background: The aim of this in vitro study was to evaluate the effect of different endodontic irrigants on the micro-tensile bond strength (μTBS) of a one-step self-etch adhesive system to dentin surfaces. **Material and methods**: Freshly extracted human incisor teeth were used as the study sample, with a total of 45 teeth included. The selection criteria excluded hypo plastic and hypo mineralized teeth, teeth with restorations, and teeth with crown fractures. A total of 45 intact human molars were selected and divided into three groups based on the irrigants used. A self-etch universal adhesive system was utilized for composite restoration. In the control group (Group 1), the dentine surface was irrigated with sodium hypochlorite (NaOCl) followed by EDTA. Group 2 received irrigation with sodium hypochlorite followed by 18% HEDP, while in Group 3, sodium hypochlorite was followed by grape seed extract as the irrigant. Resin composites were built up using the Tetric N-Bond Universal adhesive system. The micro tensile bond strength was evaluated using a Universal Testing Machine. Data analysis was done using SSPS software. **Results**: Group 1 exhibited a mean bond strength of 31.2 ± 2.10 MPa, with a 95% confidence interval (CI) ranging from 22.5 to 24.8. Group 2 had a mean bond strength of 28.6 ± 2.70 MPa, with a 95% CI of 29.5 to 32.4. Group 3 demonstrated the highest bond strength, with a mean value of 33.2 ± 3.13 MPa and a 95% CI of 31.7 to 33.5. A statistically significant difference was observed ($p < 0.002$), indicating that the bond strength varied significantly among the groups. The confidence interval values provide an estimate of the range within which the true mean bond strength is expected to lie. A significant difference was observed between Group 1 and Group 2 (mean difference: 6.5, $p < 0.002$) and between Group 1 and Group 3 (mean difference: 7.9, $p < 0.003$), indicating a statistically significant variation in bond strength. However, the comparison between Group 2 and Group 3 (mean difference: 3.7, $p = 0.121$) did not show a statistically significant difference. These findings suggest that the bond strength differs notably between certain groups, with a statistically significant threshold set at $p < 0.05$. **Conclusion**: The study revealed significant variations in bond strength among the groups, with Group 3 showing the highest values. Statistically significant differences were observed between Group 1 and the other groups, while Group 2 and Group 3 showed no significant difference.

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INTRODUCTION

Bacteria are well-established as the primary etiologic agents in the development of pulp and periapical lesions. Successful root canal therapy relies on effective chemomechanical debridement to remove pulpal tissue, dentin debris, and infectious microorganisms. Irrigants play a crucial role in enhancing mechanical debridement by flushing out debris, dissolving organic tissue, and disinfecting the root canal system. Chemical debridement is particularly essential for teeth with complex internal anatomies, such as fins or irregularities, which may not be adequately cleaned through instrumentation alone.[1,2,3]

Sodium hypochlorite (NaOCl), EDTA, and chlorhexidine (CHX) are commonly used irrigants in root canal therapy. NaOCl effectively eliminates *Enterococcus faecalis*, while EDTA aids in demineralization and canal wall cleaning. The combination of NaOCl and EDTA removes both organic and inorganic dentin components. A gentler chelating approach using etidronic acid (HEDP) was introduced to minimize dentin damage and enhance collagen stability. Grape seed extract (GSE), rich in proanthocyanidins (PACs), has shown antibacterial properties against *E. faecalis*, eliminates the smear layer, and enhances bonding strength in dental adhesives due to its potent free radical scavenging abilities.[4,5,6,7]

The aim of this in vitro study was to evaluate the effect of different endodontic irrigants on the micro-

tensile bond strength (μTBS) of a one-step self-etch adhesive system to dentin surfaces.

MATERIAL AND METHODS

Freshly extracted human incisor teeth were used as the study sample, with a total of 45 teeth included. The selection criteria excluded hypo plastic and hypo mineralized teeth, teeth with restorations, and teeth with crown fractures. A total of 45 intact human incisors were selected and divided into three groups based on the irrigants used. A self-etch universal adhesive system was utilized for composite restoration. In the control group (Group 1), the dentine surface was irrigated with sodium hypochlorite (NaOCl) followed by EDTA. Group 2 received irrigation with sodium hypochlorite followed by 18% HEDP, while in Group 3, sodium hypochlorite was followed by grape seed extract as the irrigant. Resin composites were built up using the Tetric N-Bond Universal adhesive system. The micro tensile bond strength was evaluated using a Universal Testing Machine. Data analysis was done using SSPS software.

RESULTS

Table 1: Comparison based on micro tensile bond strength in three groups

Group	N	Mean	SD	95% CI	p-value
Group 1	15	31.2	2.10	22.5-24.8	<0.002*
Group 2	15	28.6	2.70	29.5-32.4	
Group 3	15	33.2	3.13	31.7-33.5	

Statistically Significant Difference (P-value<0.05); CI: Confidence Interval

Table 1 presents the comparison of micro tensile bond strength among the three groups. Group 1 exhibited a mean bond strength of 31.2 ± 2.10 MPa, with a 95% confidence interval (CI) ranging from 22.5 to 24.8. Group 2 had a mean bond strength of 28.6 ± 2.70 MPa, with a 95% CI of 29.5 to 32.4. Group 3 demonstrated the highest bond strength, with a mean value of 33.2 ± 3.13 MPa and a 95% CI of 31.7 to 33.5. A statistically significant difference was observed ($p < 0.002$), indicating that the bond strength varied significantly among the groups. The confidence interval values provide an estimate of the range within which the true mean bond strength is expected to lie.

Table 2: Intergroup comparison based on micro tensile bond strength in three groups

Group Comparison	Mean difference	P-value
Group 1 vs Group 2	6.5	<0.002*
Group 1 vs Group 3	7.9	<0.003*
Group 2 vs Group 3	3.7	0.121

***Statistically Significant Difference (P-value<0.05)**

Table 2 presents the intergroup comparison of micro tensile bond strength among the three groups. A significant difference was observed between Group 1 and Group 2 (mean difference: 6.5, $p < 0.002$) and between Group 1 and Group 3 (mean difference: 7.9, $p < 0.003$), indicating a statistically significant variation in bond strength. However, the comparison between Group 2 and Group 3 (mean difference: 3.7, $p = 0.121$) did not show a statistically significant difference. These findings suggest that the bond strength differs notably between certain groups, with a statistically significant threshold set at $p < 0.05$.

DISCUSSION

Adhesive dentistry has significantly evolved with the development of universal adhesives, which simplify bonding procedures by allowing adhesion to different substrates with various etching modes. Among these, self-etch universal adhesives have gained attention due to their ability to demineralise dentin and simultaneously infiltrate the exposed collagen network, promoting a stable bond.[8,9]

One critical factor influencing the bonding efficacy of these adhesives is the surface condition of the dentin, particularly when it has been exposed to chemical agents such as endodontic irrigants. Various irrigants, including sodium hypochlorite (NaOCl), chlorhexidine (CHX), ethylenediaminetetraacetic acid (EDTA), and newer herbal alternatives, are commonly used during root canal treatment to disinfect and remove the smear layer. However, these agents can alter the organic and inorganic composition of dentin, potentially affecting its bonding properties.[9,10]

The micro-tensile bond strength (μTBS) test is widely used to assess the bonding performance of adhesives to dentin. It provides a quantitative evaluation of the adhesive-dentin interface under tensile stress, offering insights into the effectiveness of different adhesive systems on treated dentin.[11]

This study explores the impact of various irrigants on dentin and how self-etch universal adhesives perform in bonding under these altered conditions. Understanding these interactions is crucial for optimizing adhesive procedures and improving the long-term success of restorations in clinical practice.

In our study a Group 1 exhibited a mean bond strength of 31.2 ± 2.10 MPa, with a 95% confidence interval (CI) ranging from 22.5 to 24.8. Group 2 had a mean bond strength of 28.6 ± 2.70 MPa, with a 95% CI of 29.5 to 32.4. Group 3 demonstrated the highest

bond strength, with a mean value of 33.2 ± 3.13 MPa and a 95% CI of 31.7 to 33.5. A statistically significant difference was observed ($p < 0.002$), indicating that the bond strength varied significantly among the groups. The confidence interval values provide an estimate of the range within which the true mean bond strength is expected to lie. A significant difference was observed between Group 1 and Group 2 (mean difference: 6.5, $p < 0.002$) and between Group 1 and Group 3 (mean difference: 7.9, $p < 0.003$), indicating a statistically significant variation in bond strength. However, the comparison between Group 2 and Group 3 (mean difference: 3.7, $p = 0.121$) did not show a statistically significant difference. These findings suggest that the bond strength differs notably between certain groups, with a statistically significant threshold set at $p < 0.05$.

The study by Patrícia R.R. Brito et al.[12] evaluated the intracanal bacterial reduction achieved through chemomechanical preparation using three different irrigation techniques. Root canals from extracted teeth were contaminated with *Enterococcus faecalis* ATCC 29212 for seven days and then assigned to three experimental groups (n=20). Group 1 underwent conventional irrigation with NaviTip needles inserted 3 mm short of the working length, while Group 2 followed the same protocol but with final irrigant activation using the Endo Activator system. Group 3 utilized the EndoVac system for irrigation. In all groups, sodium hypochlorite (NaOCl) and ethylenediaminetetraacetic acid (EDTA) served as irrigants, with a total volume of 20 mL in Groups 1 and 2 and 43 mL in Group 3. A control group was irrigated with 43 mL of saline solution. Despite differences in technique and irrigant volume, all experimental groups showed a significant reduction in bacterial populations compared to the control. However, no significant differences were observed among the three tested irrigation techniques.

The study by Soares JA, et al.[13] aimed to evaluate the antimicrobial effectiveness of an alternating irrigation regimen during chemomechanical preparation (CMP). Root canals of extracted human teeth were infected with *Enterococcus faecalis* for 21 days, and colonization was confirmed using scanning electron microscopy (SEM). The samples were then divided into three groups: a control group irrigated with saline, a conventional irrigation group using 5.25% sodium hypochlorite (NaOCl) followed by a final rinse with 17% ethylenediaminetetraacetic acid (EDTA), and an alternating irrigation (AI) group where NaOCl and EDTA were used alternately. Bacterial samples were collected before treatment (S1), after CMP (S2), and for 14 days post-treatment, with two specimens per group analyzed through SEM. The AI group demonstrated superior bacterial elimination, with negative agar and liquid cultures immediately after CMP and from the 5th day onward. SEM analysis further confirmed the presence of numerous bacterium-free sites in the AI group. These findings suggest that an irrigation regimen alternating NaOCl and EDTA may be a promising endodontic approach for effectively eliminating *E. faecalis* biofilms over an extended period.

A limitation of our study was the small sample size, which may affect the generalizability of the findings. Further research with a larger cohort is needed to validate these results and provide more robust conclusions.

CONCLUSION

The study revealed significant variations in bond strength among the groups, with Group 3 showing the highest values. Statistically significant differences were observed between Group 1 and the other groups, while Group 2 and Group 3 showed no significant difference.

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