

Comparison of Plaque Removal Efficacy of a Sonic Powered Interdental Brush and Water Irrigator Around Orthodontic Brackets: A Randomized Crossover Clinical Study

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ABSTRACT

Objective:

To compare the plaque removal efficacy and gingival health outcomes of a sonic powered interdental brush and a water irrigator with an orthodontic tip in patients undergoing fixed orthodontic treatment.

Materials and Methods:

A prospective, randomized crossover clinical trial was conducted on 30 patients (12–25 years) undergoing fixed orthodontic treatment. All participants used a conventional orthodontic toothbrush throughout the study. Subjects were randomly assigned to use either a sonic powered interdental brush or a water irrigator as an adjunct for 4 weeks, followed by a 1-week washout period and crossover to the alternate aid. Plaque Index (PI) and Gingival Index (GI) scores were recorded at baseline (T0), after first intervention (T1), and after crossover (T2). Data were analyzed using ANOVA and post hoc tests ($p < 0.05$).

Results:

The powered interdental brush demonstrated significantly lower mean PI scores (1.23 ± 0.55) compared to both conventional brushing (2.12 ± 0.52) and water irrigator (2.08 ± 0.54) ($p < 0.001$). Similarly, GI scores were significantly reduced with the interdental brush (1.70 ± 0.44) compared to conventional brushing (2.05 ± 0.57) and water irrigator (2.21 ± 0.38) ($p < 0.001$). No significant difference was observed between conventional brushing and water irrigator.

Conclusions:

The sonic powered interdental brush was significantly more effective than both conventional brushing and water irrigation in reducing plaque and improving gingival health around orthodontic brackets.

Keywords:

Fixed orthodontic appliances, Sonic powered interdental brush, Water irrigator, Dental plaque, Plaque Index, Gingival Index, Oral hygiene, Orthodontic brackets, Interdental cleaning, Randomized crossover clinical trial

How to cite this article: Mazumder S, Agrawal P, Bagga DK, Priya K, Sinha A, Rachita T. Comparison of plaque removal efficacy of a sonic powered interdental brush and water irrigator around orthodontic brackets: a randomized crossover clinical study. *Int J Drug Deliv Technol.* 2026;16(6): 934-939. DOI: 10.25258/ijddt.16.6.135

INTRODUCTION

Maintenance of optimal oral hygiene is a fundamental requirement for the preservation of periodontal health. Dental plaque is a structured biofilm composed of microorganisms embedded in an extracellular matrix that adheres to tooth surfaces and gingival margins. Accumulation of plaque is the primary etiological factor in the initiation and progression of gingivitis and periodontal disease, and its effective mechanical

removal remains the cornerstone of preventive dentistry^[1,2]. Numerous clinical studies have demonstrated a direct correlation between plaque accumulation and gingival inflammation, emphasizing the importance of adequate plaque control measures^[3].

Orthodontic treatment with fixed appliances significantly alters the oral environment by introducing brackets, bands, archwires, and ligatures, which create plaque-retentive niches and impede

Comparison of Plaque Removal Efficacy of a Sonic Powered Interdental Brush and Water Irrigator Around Orthodontic Brackets: A Randomized Crossover Clinical Study

natural self-cleansing mechanisms^[4]. These appliances increase surface area and promote stagnation zones around the bracket base and beneath the archwire, making effective plaque removal challenging even for motivated patients^[5]. As a consequence, orthodontic patients are at a higher risk of developing gingivitis, periodontal inflammation, enamel decalcification, and white spot lesions during treatment^[6,7]. Conventional orthodontic toothbrushing, although routinely recommended, is often insufficient for cleaning areas adjacent to brackets and interproximal regions, leading to persistent plaque accumulation^[8,9]. Therefore, adjunctive oral hygiene aids are frequently required to enhance plaque control in orthodontic patients^[10].

Powered interdental brushes and water irrigators have been introduced to improve plaque removal in difficult-to-access areas. Powered devices provide effective mechanical disruption of plaque biofilm, while water irrigators utilize pulsatile fluid action that aids in improving gingival health. However, limited evidence exists comparing their effectiveness specifically around orthodontic brackets. Clinical trials have demonstrated that powered brushing systems may offer superior plaque removal and gingival health outcomes when compared to manual brushing, especially in patients with compromised oral hygiene ability, such as those undergoing orthodontic treatment^[13].

Therefore, the present study aimed to compare the plaque removal efficacy and gingival health outcomes of a sonic powered interdental brush and a water irrigator with an orthodontic tip in patients undergoing fixed orthodontic treatment.

MATERIALS AND METHODS

This study was designed as a prospective, randomized, crossover clinical trial conducted in patients undergoing fixed orthodontic treatment. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants prior to enrollment.

A total of 30 patients aged 12–25 years undergoing treatment with conventional fixed orthodontic appliances (0.022" MBT prescription) were included in the study. Subjects were selected based on predefined inclusion and exclusion criteria.

The study followed a crossover design with a 1:1 allocation ratio. At baseline (T0), all subjects used a conventional orthodontic toothbrush, and plaque index (PI) and gingival index (GI) scores were recorded. Subjects were then randomly allocated into two groups. Group A used a sonic powered interdental brush, and Group B used a water irrigator with an orthodontic tip as adjuncts to toothbrushing for a period of four weeks.

Patients aged 12–25 years undergoing treatment with conventional fixed orthodontic appliances (0.022" MBT prescription), with good general health and no active periodontal disease or dental caries, and who were willing to participate and provide informed consent were included in the study. Patients with power chains or figure-eight ligation, restorations on maxillary incisors, missing, fractured, or impacted central incisors, craniofacial anomalies, or those unable to comply with oral hygiene instructions were excluded. Following the first intervention phase (T1), a one-week washout period was implemented, during which only conventional brushing was performed. The interventions were then crossed over between the groups for an additional four weeks, after which final recordings were obtained (T2).

Plaque accumulation was assessed using a modified Plaque Index with site-specific evaluation around orthodontic brackets, focusing on critical gingival areas. Gingival health was assessed using the Gingival Index described by Löe and Silness^{1,2}. All clinical measurements were performed by a single calibrated examiner to ensure consistency.

Statistical analysis was performed using SPSS software. Data were analyzed using repeated measures ANOVA followed by post hoc tests. A p value of < 0.05 was considered statistically significant.

RESULTS

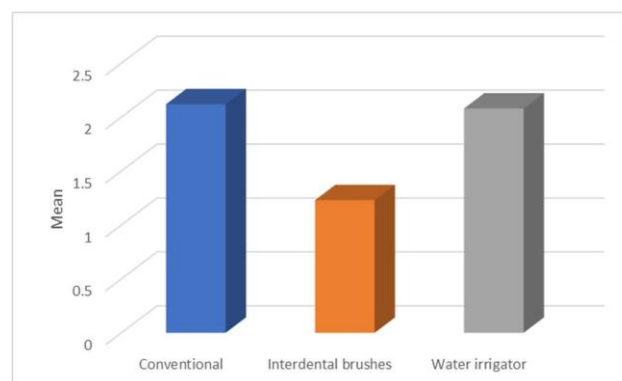
A total of 30 subjects completed the study.

Plaque Index (PI)

The mean plaque index scores differed significantly among the three groups ($p < 0.001$). The lowest mean PI score was observed in the sonic powered interdental brush group (1.23 ± 0.55), followed by the water irrigator group (2.08 ± 0.54) and the conventional brushing group (2.12 ± 0.52).

Table 1: Mean PI of study subjects in the study groups

	Minimum	Maximum	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Conventional	1.00	3.00	2.12	0.52	0.09	1.92	2.31
Interdental brushes	0.00	2.50	1.23	0.55	0.10	1.03	1.44
Water irrigator	1.00	3.00	2.08	0.54	0.10	1.88	2.29



Graph1. Graphical representation of table 1

Table 1 shows the mean Plaque Index (PI) scores among the three study groups. The Conventional group had a mean PI of 2.12 ± 0.52 (95% CI: 1.92–2.31), with values ranging from 1.00 to 3.00. The Interdental brushes group demonstrated the lowest mean PI of 1.23 ± 0.55 (95% CI: 1.03–1.44), with scores ranging from 0.00 to 2.50. The Water irrigator group had a mean PI of 2.08 ± 0.54 (95% CI: 1.88–2.29), with a range of 1.00 to 3.00.

Comparison of Plaque Removal Efficacy of a Sonic Powered Interdental Brush and Water Irrigator Around Orthodontic Brackets: A Randomized Crossover Clinical Study

These findings suggest that plaque accumulation was lowest in subjects using the interdental brush.

Table 2: Comparison of Mean PI of study subjects in the study groups

	Sum of Squares	df	Mean Square	F value	p value
Between Groups	15.039	2	7.519	25.909	<.001*
Within Groups	25.250	87	.290		
Total	40.289	89			

Table 2 presents the comparison of mean PI scores among the three groups using one-way ANOVA. The between-group sum of squares was 15.039 with 2 degrees of freedom, and the within-group sum of squares was 25.250 with 87 degrees of freedom. The calculated F value was 25.909 with a p value of <0.001, indicating a highly statistically significant difference in mean PI scores among the study groups. This indicates that at least one of the oral hygiene interventions produced a significantly different effect on plaque reduction compared to the others.

Table 3: Pairwise comparison of Mean PI of study subjects in the study groups

Groups		Mean Difference	Std. Error	p value	95% Confidence Interval	
					Lower Bound	Upper Bound
Conventional	Interdental brushes	.8833*	0.1391	<.001*	0.552	1.215
	Water irrigator	0.0333	0.1391	0.969	-0.298	0.365
Interdental brushes	Conventional	-.8833*	0.1391	<.001*	-1.215	-0.552
	Water irrigator	-.8500*	0.1391	<.001*	-1.182	-0.518
Water irrigator	Conventional	-0.0333	0.1391	0.969	-0.365	0.298
	Interdental brushes	.8500*	0.1391	<.001*	0.518	1.182

Table 3 shows a Post hoc pairwise comparison of mean PI scores between the groups. The interdental brush group demonstrated a statistically significant reduction in plaque index compared to the conventional brushing group (Mean Difference = 0.8833, $p < 0.001$).

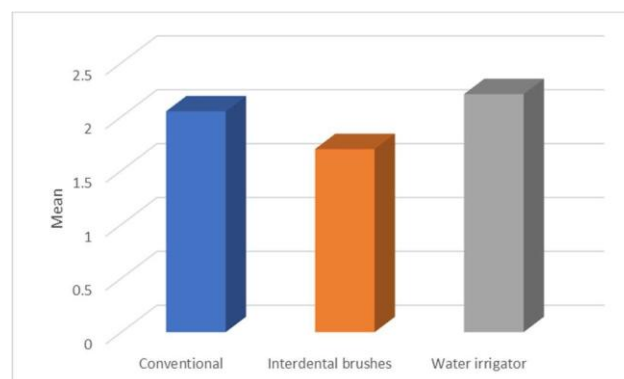
No statistically significant difference was observed between the conventional brushing and water irrigator groups (Mean Difference = 0.0333, $p = 0.969$).

Furthermore, the interdental brush group showed a statistically significant reduction in plaque index compared to the water irrigator group (Mean Difference = 0.8500, $p < 0.001$). These findings indicate that the sonic powered interdental brush was

significantly more effective in reducing plaque accumulation than both conventional brushing and water irrigation.

Table 4: Mean GI of study subjects in the study groups

	Minimum	Maximum	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Conventional	0.50	3.00	2.05	0.57	0.10	1.84	2.26
Interdental brushes	0.75	2.50	1.70	0.44	0.08	1.54	1.86
Water irrigator	1.50	3.00	2.21	0.38	0.07	2.07	2.35



Graph 2. Graphical representation of table 4

Table 4 shows the mean Gingival Index (GI) scores among the study groups. The Conventional group had a mean GI of 2.05 ± 0.57 (95% CI: 1.84–2.26), with values ranging from 0.50 to 3.00. The Interdental brushes group had a mean GI of 1.70 ± 0.44 (95% CI: 1.54–1.86), with scores ranging from 0.75 to 2.50. The Water irrigator group demonstrated the highest mean GI of 2.21 ± 0.38 (95% CI: 2.07–2.35), with values between 1.50 and 3.00.

Table 5. Comparison of Mean GI of study subjects in the study groups

	Sum of Squares	df	Mean Square	F value	p value
Between Groups	4.060	2	2.030	9.302	<.001*
Within Groups	18.985	87	.218		
Total	23.045	89			

Table 5 presents the comparison of mean GI scores using one-way ANOVA. The between-group sum of squares was 4.060 with 2 degrees of freedom, while the within-group sum of squares was 18.985 with 87 degrees of freedom. The F value was 9.302 with a p value of <0.001, indicating a statistically

Comparison of Plaque Removal Efficacy of a Sonic Powered Interdental Brush and Water Irrigator Around Orthodontic Brackets: A Randomized Crossover Clinical Study

significant difference in mean GI scores among the three groups.

This indicates that at least one of the oral hygiene interventions produced a significantly different effect on gingival inflammation compared to the others.

Table 6: Pairwise comparison of Mean GI of study subjects in the study groups

Groups		Mean Difference	Std. Error	p value	95% Confidence Interval	
					Lower Bound	Upper Bound
Conventional	Interdental brushes	.35000*	0.12062	0.013*	0.0624	0.6376
	Water irrigator	-0.15833	0.12062	0.392	-0.4459	0.1293
Interdental brushes	Conventional	-.35000*	0.12062	0.013*	-0.6376	-0.0624
	Water irrigator	-.50833*	0.12062	<.001*	-0.7959	-0.2207
Water irrigator	Conventional	0.15833	0.12062	0.392	0.1293	0.4459
	Interdental brushes	.50833*	0.12062	<.001*	0.2207	0.7959

Table 6 shows the post hoc pairwise comparison of mean GI scores between the groups. The Interdental brushes group had a significantly lower mean GI compared to the Conventional group (mean difference = 0.35000, $p = 0.013$; 95% CI: 0.0624–0.6376) and the Water irrigator group (mean difference = 0.50833, $p < 0.001$; 95% CI: 0.2207–0.7959). There was no statistically significant difference between the Conventional and Water irrigator groups (mean difference = -0.15833, $p = 0.392$; 95% CI: -0.4459 to 0.1293).

These findings indicate that the sonic powered interdental brush was significantly more effective in improving gingival health than both conventional brushing and water irrigation.

DISCUSSION

Orthodontic appliances create plaque-retentive areas that compromise oral hygiene and increase the risk of gingivitis and enamel demineralization.

The present study demonstrated that the sonic powered interdental brush was more effective than both conventional toothbrushing and water irrigation in reducing plaque accumulation and gingival inflammation. This may be attributed to its combined mechanical and hydrodynamic action. Sreenivasan et al.^[14] reported that powered devices generate hydrodynamic forces capable of disrupting plaque beyond direct bristle contact, supporting the findings of the present study.

The results are consistent with studies by Boyd et al.^[7] and Hickman et al.^[8], who demonstrated superior plaque reduction with powered brushing in orthodontic patients. Similarly, Bock

et al.^[10] and Kossack and Jost-Brinkmann^[9] emphasized the effectiveness of interdental brushes in improving plaque control around orthodontic brackets.

Although both adjunctive aids showed improvement, the water irrigator did not produce significant plaque reduction compared to conventional brushing. Sharma et al.^[11] reported that water irrigators are more effective in improving gingival health than in reducing plaque, which aligns with the findings of the present study.

The lesser improvement in gingival index compared to plaque reduction may be due to delayed tissue response. Costa et al.^[16] and Clerehugh et al.^[3] reported that gingival healing requires sustained plaque control over time. Additionally, Van der Weijden and Slot^[15] and Sambunjak et al.^[17] highlighted that gingival improvement depends on factors such as duration, technique, and patient compliance.

Most previous studies have evaluated either manual interdental brushes or powered toothbrushes. In contrast, the present study specifically compared a sonic powered interdental brush with a water irrigator in orthodontic patients. Mancinelli-Lyle et al.^[18] reported greater gingival improvement with water flossers in non-orthodontic patients; however, in the present orthodontic population, the powered interdental brush demonstrated superior outcomes, likely due to enhanced mechanical plaque disruption.

Similarly, Erbe et al.^[13] demonstrated greater plaque removal with interdental brushes around orthodontic brackets, supporting the present findings.

Potential adverse effects should also be considered. Marconi et al.^[20] reported possible dentine wear with prolonged use of interdental brushes, while Schmidlin et al.^[19] emphasized proper selection and usage. In contrast, water irrigators are generally associated with minimal abrasion risk.

Despite its strengths, the present study has certain limitations. The sample size was relatively limited and the duration of each intervention phase was short, which may restrict the generalizability of the findings and the ability to assess long-term effects on gingival health. Gingival tissues often require prolonged periods of sustained plaque control to exhibit complete clinical resolution of inflammation, particularly in patients undergoing fixed orthodontic treatment, where appliances continue to act as plaque-retentive factors. Additionally, the study was conducted at a single center, which may limit the external validity of the results and microbiological analysis was not performed, which could have provided further insight into changes in periodontal pathogens. Also, the effectiveness of these interdental aids may differ depending on the type of orthodontic appliance used, such as ceramic or self-ligating brackets, as variations in bracket design can influence plaque accumulation.

In addition, future investigations should consider comparing manual toothbrushes, powered toothbrushes, powered interdental brushes, and water irrigators together to provide a more comprehensive understanding of their relative effectiveness in orthodontic patients. Such comparisons would help clinicians make more evidence-based recommendations for daily oral hygiene practices. Inclusion of microbiological and biochemical parameters could also provide deeper insight into changes in the periodontal environment during orthodontic treatment.

Additionally, multi-center studies with larger sample sizes are recommended to improve the generalizability of the findings across different populations and clinical settings. Further

Comparison of Plaque Removal Efficacy of a Sonic Powered Interdental Brush and Water Irrigator Around Orthodontic Brackets: A Randomized Crossover Clinical Study

research may also evaluate these interdental aids in patients treated with different types of orthodontic appliances, such as ceramic or self-ligating brackets, as appliance design may influence plaque accumulation and gingival response. Conducting studies in varied clinical environments would provide broader insight into their real-world effectiveness.

CONCLUSION

Based on the findings of the present study, the following conclusions can be drawn:

- Conventional toothbrushing contributed to a measurable reduction in plaque accumulation and gingival inflammation in patients undergoing fixed orthodontic treatment. However, due to the plaque-retentive nature of orthodontic appliances, routine brushing alone may not be sufficient to achieve optimal oral hygiene. The use of adjunctive powered oral hygiene aids further enhanced plaque control and gingival health.
- The sonic powered interdental brush demonstrated a statistically significant reduction in plaque index and gingival index scores when compared to conventional toothbrushing alone. This indicates its superior efficacy as an adjunctive oral hygiene aid in patients undergoing fixed orthodontic treatment.
- The water irrigator did not show a statistically significant improvement in plaque accumulation or gingival inflammation when compared to conventional toothbrushing. This suggests that, in our present study, the water irrigator did not provide additional clinical benefit over routine brushing.
- Direct comparison between the sonic powered interdental brush and the water irrigator revealed significantly greater plaque removal and gingival health improvement with the interdental brush. This confirms that the mechanical vibratory action of the powered interdental brush may offer enhanced plaque disruption in plaque-retentive orthodontic environments.
- Overall, the sonic powered interdental brush emerged as the most effective adjunctive oral hygiene aid among the interventions evaluated, demonstrating both statistical significance and clinical relevance.

Declaration: The study has received no funding and has no conflicts of interest.

Author Contribution:

Shibangi Mazumder: Conceptualization, Methodology, Writing-Original Draft

Poonam Agrawal: Conceptualization, Methodology, Writing Original Draft

Dinesh Kumar Bagga: Data Analysis and Interpretation

Kanak Priya: Supervision and Manuscript writing

Abhishek Sinha: Data Analysis

T Rachita: Manuscript writing

REFERENCES

1. Löe H, Silness J. Periodontal disease in pregnancy I. Prevalence and severity. *Acta Odontol Scand.* 1963;21:533–51.
2. Silness J, Löe H. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand.* 1964;22:121–13.
3. Clerehugh V, Williams P, Shaw WC, Worthington HV, Warren P. A practice-based randomized controlled trial of the efficacy of an electric and a manual toothbrush on gingival health in patients with fixed orthodontic appliances. *J Dent.* 1998;26(8):633–39.
4. Schätzle M, Imfeld T, Sener B, Schmidlin PR. In vitro tooth cleaning efficacy of manual toothbrushes around brackets. *Eur J Orthod.* 2009;31(1):103–07.
5. Rafe Z, Vardimon AD, Ashkenazi M. Comparative study of three types of toothbrushes in patients with fixed orthodontic appliances. *Am J Orthod Dentofacial Orthop.* 2006;130(1):92–95.
6. Trimpeneers LM, Wijgaerts IA, Grogard NA, Dermaut LR, Adriaens PA. Effect of electric toothbrushes versus manual toothbrushes on removal of plaque and periodontal status during orthodontic treatment. *Am J Orthod Dentofacial Orthop.* 1997;111(5):492–97.
7. Boyd RL, Murray P, Robertson PB. Effect of rotary electric toothbrush versus manual toothbrush on periodontal status during orthodontic treatment. *Am J Orthod Dentofacial Orthop.* 1989;96(4):342–47.
8. Hickman J, Millett DT, Sander L, Brown E, Love J. Powered versus manual tooth brushing in fixed appliance patients: a short-term randomized clinical trial. *Angle Orthod.* 2002;72(2):135–40.
9. Kossack C, Jost-Brinkmann PG. Plaque and gingivitis reduction in patients undergoing orthodontic treatment with fixed appliances: comparison of toothbrushes and interdental cleaning aids. A 6-month clinical single-blind trial. *J Orofac Orthop.* 2005;66(1):20–38.
10. Bock NC, von Bremen J, Ruf S. Plaque control effectiveness and handling of interdental brushes in multibracket patients. *Eur J Orthod.* 2010;32(4):408–13.
11. Sharma NC, Lyle DM, Qaqish JG, Galustians HJ, Schuller R. Effect of a dental water jet with orthodontic tip on plaque and bleeding in adolescent patients with fixed orthodontic appliances. *Am J Orthod Dentofacial Orthop.* 2007;131(4):525–31.
12. Erbe C, Klukowska M, Timm H, Barker ML, van der Wielen J, Wehrbein H. A randomized controlled trial of a power brush/irrigator/mouthrinse routine on plaque and gingivitis reduction in orthodontic patients. *Angle Orthod.* 2018;88(6):747–54.
13. Erbe C, Zanders-Grote L, Wagner Y, Schmidtman I, Lang NP, Wehrbein H. Randomized multicenter study on the plaque removal efficacy of two interdental brushes around the base of orthodontic brackets. *Am J Orthod Dentofacial Orthop.* 2023;164(4):563–72.
14. Sreenivasan PK, Qaqish JG, Gaffar A. Mechanisms of plaque removal by powered toothbrushes. *J Clin Dent.* 2011;22(3):79–85.
15. Van der Weijden GA, Slot DE. Oral hygiene in orthodontic patients: a systematic review. *Am J Orthod Dentofacial Orthop.* 2011;139(5):548–59.
16. Costa MR, Silva VC, Miquel JL. Gingival health during orthodontic treatment: a clinical evaluation. *Eur J Orthod.* 2007;29(2):144–49.
17. Sambunjak D, Nickerson JW, Poklepovic T, et al. Interdental brushing for the prevention and control of

Comparison of Plaque Removal Efficacy of a Sonic Powered Interdental Brush and Water Irrigator Around Orthodontic Brackets: A Randomized Crossover Clinical Study

- periodontal diseases and dental caries in adults. *Cochrane Database Syst Rev*. 2011;(12):CD009857.
18. Mancinelli-Lyle D, Van der Weijden F, Slot DE. Efficacy of a water flosser compared to an interdental brush on gingival bleeding and gingival abrasion: A 4 week randomized controlled trial. *International Journal of Dental Hygiene*. 2025 Feb;23(1):176-85.
 19. Schmidlin PR, Schmidlin TM, Gubler A, Brändli S, Attin T. Description of a new laboratory evaluation method of interdental brush abrasion as a clinical hazard. *International Journal of Dental Hygiene*. 2024 May;22(2):458-64.
 20. Marconi C, Gubler A, Wegehaupt FJ, Schmidlin PR. The Influence of Interdental Brushes and Toothpaste On Approximal Enamel and Dentine Abrasion—A Laboratory Study. *Oral Health & Preventive Dentistry*. 2025 Apr 15;23:21.