RESEARCH ARTICLE

ASSESSMENT OF THE RATE OF DEMINERALISATION IN BANDED PERMANENT FIRST MOLARS USING DIFFERENT MOLAR BANDING PROTOCOLS: A SPLIT-MOUTH PILOT STUDY

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ABSTRACT

Background: Molar bands encircle the crown and create plaque-retentive areas that predispose the enamel to demineralisation, yet they are usually left in place for the whole of orthodontic treatment. This pilot study compared enamel demineralisation in permanent first molars under continuous band retention and periodic re-banding.

Materials and Methods: In this split-mouth pilot clinical trial, 20 patients (11 males, 9 females; mean age 20.40 ± 4.48 years) undergoing fixed orthodontic treatment contributed 40 permanent first molars. One molar in each patient was randomly allocated to continuous band retention (control) and the contralateral molar to band removal and re-banding at 2-month intervals (experimental) for 12 months. Demineralisation was scored on standardised intraoral photographs by three blinded examiners using ICDAS-II, dichotomised as sound or demineralised. Probing depth and patient-reported discomfort were also recorded.

Results: Inter-examiner agreement was fair to moderate ($\kappa = 0.316–0.438$). Buccal demineralisation was recorded in 14–18 control molars versus 3–5 experimental molars ($p \leq 0.014$ for all examiners), and the lingual difference was significant for two of the three examiners. Combined buccal and lingual scores differed significantly between the groups for all examiners ($p = 0.001$). Probing depth did not differ between the groups at 12 months ($p = 0.114$), and 80% of patients reported no or only mild discomfort with re-banding.

Conclusion: Periodic re-banding at 2-month intervals was associated with less enamel demineralisation than continuous band retention over 12 months, with acceptable patient comfort. Larger randomised trials using objective diagnostic methods are needed to confirm these findings.

Keywords: Enamel demineralisation, White spot lesions, Molar bands, Orthodontic banding, ICDAS, Split-mouth design.

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INTRODUCTION

Orthodontic treatment aims to achieve proper alignment of the teeth and a harmonious relationship between the dental arches and jaws, thereby improving mastication, speech, facial aesthetics and oral health, and enhancing the patient's quality of life.[1] Like any therapeutic intervention, however, it carries potential risks and complications, although their

incidence is generally lower than that of many other surgical and non-surgical procedures.[1,2] The adverse effects may be local or systemic. Local complications include tooth discolouration, enamel decalcification, root resorption and periodontal problems, whereas systemic effects such as allergic reactions, gastrointestinal disturbances, infective endocarditis, psychological disturbances and chronic fatigue syndrome occur less frequently.[1,3,4] Among these, enamel demineralisation is one of the most commonly encountered clinical problems.

Enamel is the hardest tissue in the human body and is composed mainly of highly organised hydroxyapatite crystals arranged in tightly packed prisms.[5] Despite its mineral content of approximately 96% by weight, it remains susceptible to demineralisation under prolonged acidic conditions.[6] Demineralisation is the earliest stage of dental caries and is characterised by subsurface mineral loss, while the outer surface initially remains relatively intact.[7] It occurs when acidogenic microorganisms in dental plaque metabolise fermentable carbohydrates and produce organic acids that lower the plaque pH below the critical level of approximately 5.5. Hydroxyapatite then dissolves, producing microscopic porosities, and repeated acid exposure results in chalky, white, opaque areas known as white spot lesions (WSLs).[7]

WSLs are the earliest clinically detectable stage of enamel demineralisation and are commonly observed during orthodontic treatment.[3] Their prevalence in orthodontic patients has been reported to range from 10% to 49%.[8] As they arise from a non-developmental process, they can generally be distinguished from developmental enamel defects by their location, shape and progression over time.[9] Their opaque appearance results from mineral loss and the difference in refractive index between sound enamel and the water or air occupying the porous demineralised spaces.[10] Increased porosity reduces translucency, while surface irregularities scatter light and cause loss of the normal lustre.[11] Although WSLs may develop rapidly, they usually become visible only after the tooth surface has been dried;[12] when detected early, the enamel retains the potential for remineralisation.[8]

Fixed appliances promote plaque retention and interfere with routine oral hygiene, so the risk of WSLs rises considerably during treatment.[13] The development of non-cavitated WSLs adjacent to orthodontic attachments is among the most undesirable consequences of fixed therapy.[14] Contributing factors include inadequate oral hygiene, prolonged plaque retention, loose bands, contamination during cementation and dehydration of the tooth surface.[15] Reduced salivary flow and buffering capacity further limit natural cleansing and neutralisation, favouring the persistence of microorganisms and food debris and reducing the potential for remineralisation.[16]

Molar bands have been particularly associated with plaque retention and enamel demineralisation. Posterior teeth often serve as anchorage units, which requires secure attachment of the appliance.[17] Cemented bands provide strong and stable attachment compared with bonded brackets,[18] and bonded molar tubes show higher failure rates owing to heavy masticatory forces, occlusal interference, moisture contamination and gingival fluid seepage.[18,19] Unlike bonded brackets, however, bands encircle the entire crown and create circumferential plaque retention areas, and cement extruded along the margins may produce irregular interfaces that facilitate bacterial adherence.[20] Band margins frequently approximate the supragingival or occasionally the subgingival environment,[21,22] interfering with salivary flow, crevicular fluid movement, tongue activity and mechanical food clearance, so that these sites may act as stable reservoirs for biofilm accumulation and maturation.[23] When bands remain cemented for prolonged periods, continuous exposure of the cement–tooth interface to plaque acids may cause progressive subsurface mineral loss, while masticatory fatigue can degrade the cement and create microgaps that permit bacterial colonisation and acid penetration.[24]

Periodic removal and replacement of bands may disrupt this biofilm: mechanical removal eliminates mature plaque and residual cement, and recementation restores the cement interface, which may reduce prolonged plaque stagnation. Glass ionomer cements (GICs), commonly used for band cementation, release fluoride, which promotes fluorapatite formation and enhances enamel resistance to acid dissolution.[25] This release declines progressively as the cement equilibrates with the oral environment, so the protective effect may diminish in bands left in situ while plaque accumulation continues. Periodic replacement could therefore renew fresh fluoride-releasing cement layers, although this must be balanced against possible enamel abrasion during repeated band removal.

Accurate detection and monitoring of demineralisation are essential for evaluating preventive strategies, and several diagnostic modalities that differ in sensitivity, specificity, cost and clinical applicability are available.[26] Visual examination remains the most widely used method owing to its simplicity and non-invasive nature,[27] but inspection without standardised criteria is subjective and may be insensitive to early lesions. This has led to the introduction of structured visual scoring systems and optical techniques such as fluorescence-based methods, laser diagnostics and digital photographic analysis.[28-31] The International Caries Detection and Assessment System (ICDAS) provides a standardised and reliable method based on examination of clean, dried tooth surfaces, using a scale of 0 to 6 from sound enamel to extensive cavitated lesions.[32] Code 0 represents a sound surface, Code 1 the first visual change in enamel detectable only after air drying, and Code 2 a distinct visual change visible without drying; these early codes are relevant to incipient WSLs.[32,33] ICDAS offers improved sensitivity for early enamel changes, standardised criteria and better intra- and inter-examiner reliability.[34]

Demineralisation risk during orthodontic treatment is strongly time dependent: the longer plaque remains undisturbed against the enamel, the greater the likelihood of subsurface mineral loss. Continuous banding throughout treatment may promote prolonged plaque maturation at the cement–tooth interface, whereas periodic band replacement may interrupt biofilm maturation and reduce cumulative acid exposure. In routine practice, however, molar bands are usually left in place for the entire treatment, and the effect of continuous versus periodically replaced bands on enamel demineralisation has not been adequately investigated. To the best of the authors' knowledge, no

published study has compared the rate of demineralisation under these two protocols using a standardised scoring system. A split-mouth design, which allows direct intra-individual comparison and minimises confounding by diet, oral hygiene, salivary characteristics and host susceptibility, combined with ICDAS scoring and standardised DSLR photographic documentation, offers a reliable, non-invasive means of doing so.

The present pilot study aimed to assess and compare enamel demineralisation in permanent first molars subjected to two different banding protocols during fixed orthodontic treatment: continuous band retention and periodic band replacement at two-month intervals over a 12-month period. The primary objective was to compare the occurrence and severity of enamel demineralisation between the two protocols using ICDAS-II. The secondary objectives were to evaluate periodontal probing depth and patient-reported discomfort associated with the procedures and to document enamel changes using standardised intraoral photographs.

Null hypothesis: There would be no difference in the occurrence or severity of enamel demineralisation between continuous band retention and periodic band replacement.

Alternative hypothesis: Enamel demineralisation would differ between the two protocols, with periodic band replacement potentially reducing its occurrence or severity.

MATERIALS AND METHODS

Study Design and Setting

This split-mouth pilot clinical trial was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Sri Venkateshwaraa Dental College, Ariyur, Puducherry, India, between June 2024 and June 2025. Each participant was followed up for 12 months. In a split-mouth design each patient acts as his or her own control, which minimises inter-individual variability.[35] The study is reported in accordance with the CONSORT 2010 guidelines[36] (Figure 1).

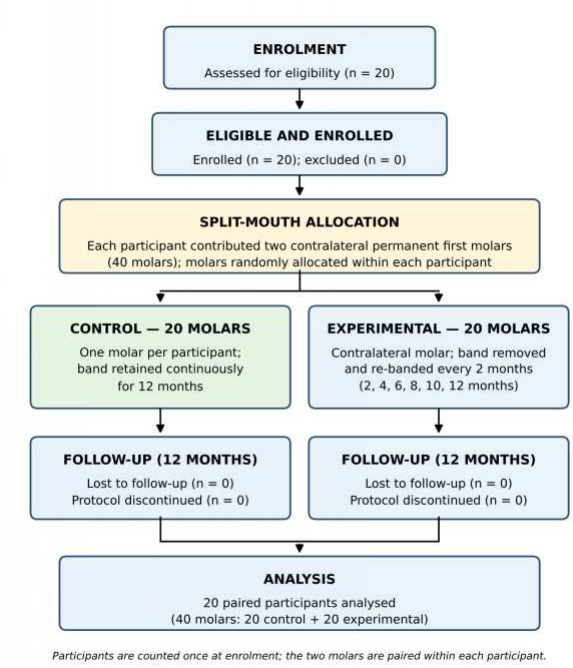


Figure 1: CONSORT flow diagram of the split-mouth pilot clinical trial

Participants and Sample Size

Twenty patients undergoing fixed orthodontic treatment (11 males and 9 females; mean age 20.40 ± 4.48 years) were enrolled by convenience sampling, as the study was a pilot intended to obtain preliminary data and assess feasibility. Each patient contributed two permanent first molars, giving a total of 40 molars for evaluation.

Inclusion criteria: Patients undergoing fixed orthodontic treatment, with a fully erupted permanent dentition, who gave informed consent were included.

Exclusion criteria: Patients were excluded if they had missing or extracted first permanent molars; molars with pre-existing enamel defects, restorations, hypoplasia or visible demineralisation; periodontally compromised teeth; or systemic diseases; or if they required adjunctive anchorage devices (headgear, lingual arch or palatal arch).

Group Allocation and Study Groups

For each patient, one first permanent molar was allocated to the control group and the contralateral molar to the experimental group by simple randomisation using computer software. In the control group, the molar band was placed at baseline and left in position, without removal, for the 12-month study period. In the experimental group, the band was placed at baseline and then removed and re-banded at 2-month intervals (2, 4, 6, 8, 10 and 12 months). All clinical procedures were performed by the same operator.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki (1975, revised 2013). Institutional Review Board clearance (SVDC/IRB/2024/1203/PG THESIS/14) and Institutional Ethics Committee clearance (SVDC/IEC-Cer/2024-25/83) were obtained before the commencement of the study. Written informed consent was obtained from all participants (and from parents or

guardians where applicable). Photographs were cropped to show only the first molar. All data, including photographs, ICDAS scores, probing depths and questionnaires, were stored in a password-protected database accessible only to the principal investigator and supervising faculty, and patient confidentiality was maintained throughout.

Materials

Preformed stainless steel molar bands with an MBT 0.022-inch tube (Captain Ortho, India) were cemented with GC Gold Label 1 Luting and Lining glass ionomer cement (GC Corporation, Tokyo, Japan). The armamentarium (Figure 2) comprised a band seater, band pusher and band remover, a mouth mirror and curved explorer, cheek retractors, an intraoral photographic mirror, a periodontal probe and a digital camera with ring flash; an ICDAS scoring chart and a patient comfort questionnaire were also used.



Figure 2: Armamentarium used in the study

Clinical Procedure

At baseline, a comprehensive intraoral examination was performed before band placement, standardised intraoral photographs were taken, probing depth was recorded and oral hygiene instructions were given. Bands were adapted and cemented with the glass ionomer cement; excess cement was removed and the position of the band and the occlusion were verified. At each 2-month follow-up, bands in the experimental group were removed and replaced, with photographs and probing depth recorded before each re-banding. Bands in the control group were not removed.

Photographic Standardisation

Intraoral photographs were taken with a Canon R10 mirrorless camera (Canon Inc., Tokyo, Japan) fitted with an 85 mm RF macro lens and ring flash, using fixed settings (ISO 200, aperture f/22, shutter speed 1/160) (Figure 3). All photographs were taken by the same operator in a designated photography room under uniform ceiling lighting, at the minimum focusing distance of 0.35 m confirmed with the camera's focusing distance meter. Patients were positioned uniformly, cheek retractors were used, and the photographic mirror was used for lingual views. Images were processed in Adobe Photoshop 2026 (Adobe Inc., San Jose, USA) and cropped to a 1:1 ratio focusing exclusively on the first molar, with standardised cropping dimensions and orientation; no enhancements or filters were applied.



Figure 3: Standardised camera settings

Assessment of Demineralisation

Enamel demineralisation was assessed using the ICDAS-II criteria[32,33] at baseline and at the follow-up intervals. For analysis, scores were dichotomised as Score 1 (ICDAS code 0, sound enamel) (Figure 4) and Score 2 (ICDAS codes 1–6, presence of demineralisation or caries activity) (Figure 5). Before the study, the three examiners were calibrated using a set of standardised intraoral photographs covering the full range of ICDAS scores; each examiner scored the images independently, the results were compared and discussed, and the exercise was repeated until acceptable agreement was reached. Standardised intraoral photographs were coded and anonymised, and the examiners were blinded to group allocation during ICDAS scoring.



Figure 4: Score 1 (ICDAS code 0, sound enamel)

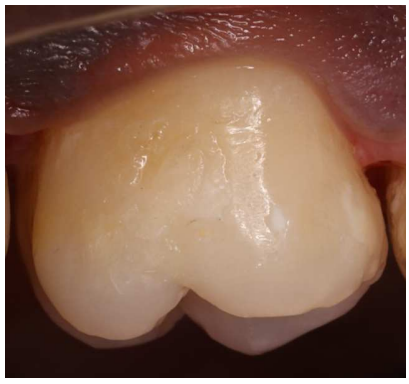


Figure 5: Score 2 (ICDAS codes 1–6, demineralisation present)

Periodontal Assessment

Probing depth around the banded first molars was recorded with a Williams periodontal probe (Figure 6) by the same examiner using a consistent technique. In the control group

it was recorded at baseline, before band placement, and at 12 months; in the experimental group it was recorded at baseline and at 2, 4, 6, 8, 10 and 12 months.



Figure 6: Periodontal assessment with a Williams periodontal probe

Patient Comfort

At the end of the study, patients completed a questionnaire rating the discomfort associated with band placement and re-banding on a scale of 1 to 6.

Statistical Analysis

Data were entered into a spreadsheet and analysed using SPSS version 27 (IBM Corp., Armonk, NY, USA). A p-value <0.05 was considered statistically significant. Categorical data were expressed as frequencies and percentages, and continuous data as mean ± standard deviation (SD), median and range. ICDAS scores were treated as ordinal data. Inter-examiner reliability of ICDAS scoring was assessed using Cohen's kappa (κ), with its standard error, test statistic and p-value. The distribution of ICDAS scores between the control and experimental groups, for buccal and lingual surfaces, was compared using the Mann–Whitney U test, as the data were ordinal and non-parametric. The mean age of male and female participants was compared using the independent samples t-test. Because probing depth was not normally distributed, the control and experimental groups were compared at baseline and at 12 months using the Mann–Whitney U test; within the control group, baseline and 12-month values were compared using the Wilcoxon signed-rank test, with the mean difference, standard error and 95% confidence interval reported. In the experimental group, probing depth across the seven time points (baseline and 2, 4, 6, 8, 10 and 12 months) was analysed using Cochran's Q test. Patient discomfort scores, being ordinal, were summarised using frequencies and percentages.

RESULTS

Data from all 20 patients and 40 molars (20 molars in each group) were analysed. There were 11 males (55.0%) and 9 females (45.0%), with a mean age of 20.40 ± 4.48 years. Males were older than females on average, but the difference was not significant (p=0.11) (Table 1).

Table 1: Baseline characteristics of the study participants

Variable	Category	n (%)	Mean ± SD	p-value
Gender	Male	11 (55.0)	–	–
	Female	9 (45.0)	–	–
Age (years)	Male	11	21.91 ± 3.53	0.11
	Female	9	18.56 ± 5.00	
Overall		20 (100)	20.40 ± 4.48	–

Values are frequency (percentage) or mean ± standard deviation (SD). The p-value for age was calculated using the independent samples t-test.

Inter-examiner agreement for ICDAS scoring ranged from fair to moderate (κ=0.316 to 0.438, all p≤0.005) and was highest between Examiners 1 and 3 (Table 2).

Table 2: Inter-examiner reliability of ICDAS scoring (Cohen's kappa)

Comparison	κ	SE	T	p-value	Interpretation
Examiner 1 vs 2	0.328	0.118	2.98	0.003	Fair
Examiner 1 vs 3	0.438	0.112	4.01	<0.001	Moderate
Examiner 2 vs 3	0.316	0.120	2.84	0.005	Fair

κ: Cohen's kappa coefficient; SE: standard error; T: test statistic.

All three examiners recorded the dichotomised ICDAS score 2 (ICDAS codes 1–6) in more control molars than experimental molars (Table 3). On the buccal surface the difference was significant for every examiner (p=0.001 to 0.014); for example, Examiner 1 recorded demineralisation in 18 of 20 control molars against 3 of 20 experimental molars. On the lingual surface the difference was significant for Examiners 1 and 2 (p=0.002 and 0.014) but not for Examiner 3 (p=0.108).

Table 3: Molars showing demineralisation in the control and experimental groups, by examiner and tooth surface

Examiner	Surface	Control (n=20) n (%)	Experimental (n=20) n (%)	p-value
1	Buccal	18 (90.0)	3 (15.0)	0.001
	Lingual	14 (70.0)	3 (15.0)	0.002
2	Buccal	14 (70.0)	5 (25.0)	0.014
	Lingual	15 (75.0)	6 (30.0)	0.014
3	Buccal	17 (85.0)	4 (20.0)	0.001
	Lingual	9 (45.0)	3 (15.0)	0.108

Dichotomised score 2 corresponds to ICDAS codes 1–6. p-values were calculated using the Mann–Whitney U test. ICDAS: International Caries Detection and Assessment System.

The combined score for each molar was calculated as the sum of its buccal and lingual scores (score 2: both surfaces sound; score 3: one surface demineralised; score 4: both surfaces demineralised). The distribution of combined scores differed significantly between the control and experimental groups for all three examiners (p=0.001 for each examiner) (Table 4). Most experimental molars had both surfaces sound (10–15 of 20, depending on the examiner), whereas 18–20 of the 20 control molars had one or both surfaces affected. Both surfaces were affected in 7–12 control molars, compared with only one experimental molar for each examiner.

Table 4: Distribution of combined buccal and lingual ICDAS scores in the control and experimental groups, by examiner

Examiner	Combined score	Control (n=20) n (%)	Experimental (n=20) n (%)	p-value
1	2	0 (0.0)	15 (75.0)	0.001
	3	8 (40.0)	4 (20.0)	
	4	12 (60.0)	1 (5.0)	
2	2	2 (10.0)	10 (50.0)	0.001
	3	7 (35.0)	9 (45.0)	

Examiner	Combined score	Control (n=20) n (%)	Experimental (n=20) n (%)	p-value
	4	11 (55.0)	1 (5.0)	
3	2	1 (5.0)	14 (70.0)	0.001
	3	12 (60.0)	5 (25.0)	
	4	7 (35.0)	1 (5.0)	

Score 2: both surfaces sound; score 3: one surface demineralised; score 4: both surfaces demineralised. Percentages are of the 20 molars in each group. p-values were calculated using the Mann–Whitney U test.

Mean probing depth did not differ significantly between the control and experimental groups at baseline (p=0.755) or at 12 months (p=0.114) (Table 5). Within the control group, probing depth increased significantly from baseline to 12 months (mean difference −0.20 ± 0.41 mm; standard error 0.09; 95% CI −0.39 to −0.01; p=0.042). In the experimental group, probing depth was unchanged at all seven time points (baseline and 2, 4, 6, 8, 10 and 12 months), with a mean of 2.45 ± 0.51 mm and a median of 2.00 mm (range 2.00–3.00) throughout (Cochran's Q test, p=1.00).

Table 5: Periodontal probing depth (mm) in the control and experimental groups at baseline and 12 months

Time point	Control mean ± SD	Control median (range)	Experimental mean ± SD	Experimental median (range)	p-value
Baseline	2.50 ± 0.51	2.50 (2.00–3.00)	2.45 ± 0.51	2.00 (2.00–3.00)	0.755
12 months	2.70 ± 0.47	3.00 (2.00–3.00)	2.45 ± 0.51	2.00 (2.00–3.00)	0.114

Values are mean ± standard deviation (SD) and median (range). Between-group comparisons were performed using the Mann–Whitney U test.

Patient-reported discomfort scores ranged from 1 to 3. Five patients (25.0%) reported no discomfort (score 1), 11 (55.0%) reported mild discomfort (score 2) and four (20.0%) reported moderate discomfort (score 3); no patient reported a score above 3 (Table 6).

Table 6: Distribution of patient-reported discomfort scores

Discomfort score	Frequency (n)	Percent (%)
1 (No pain/discomfort)	5	25.0
2 (Mild pain/discomfort)	11	55.0
3 (Moderate pain/discomfort)	4	20.0
Total	**20**	**100.0**

Values are frequency (n) and percentage (%).

DISCUSSION

Enamel demineralisation is one of the most common adverse effects of fixed orthodontic therapy. Appliances create plaque-retentive areas that predispose the enamel to acid-mediated mineral loss and the formation of WSLs. The reported prevalence varies widely, from 2% to 96%, depending on the diagnostic criteria, the duration of treatment and patient-related factors.[37,38]

This pilot study compared the rate of enamel demineralisation in banded permanent first molars under continuous banding and periodic re-banding. Baseline comparability is essential for the validity of a clinical study,[39] and the split-mouth design helped to achieve it, because both protocols were applied under identical intraoral conditions in the same patient.[35] Molars with pre-existing demineralisation were excluded, probing depth was similar in the two groups at baseline (p=0.755), and males and females did not differ significantly in age (p=0.11).

Inter-examiner agreement for ICDAS scoring was fair to moderate (κ=0.316 to 0.438). This is lower than the kappa values of 0.59 to 0.82 reported by Ismail et al.,[32] and the reliability of ICDAS is known to depend on examiner experience and calibration.[34] The agreement obtained here must therefore be regarded as a limitation, although all three examiners found the same direction of effect.

Demineralisation was less frequent and less extensive in the experimental molars than in the control molars. The difference was significant on the buccal surface for all three examiners and on the lingual surface for two of the three, and the combined score differed significantly for every examiner (p=0.001). The absence of a significant lingual difference for Examiner 3 (p=0.108) may reflect differences in visual access, plaque accumulation pattern or examiner subjectivity.

Demineralisation was common under continuous banding: by the combined score, 18 to 20 of the 20 control molars had at least one affected surface, depending on the examiner. This exceeds the incidence of about 50% reported by Gorelick et al.[9] and the 72.9% reported by Richter et al.[40] The comparison should be made cautiously, as those figures relate to patients rather than molars, but ICDAS can also detect early non-cavitated lesions that conventional methods may miss. WSLs can develop within four weeks of appliance placement, owing to rapid plaque accumulation and the establishment of an acidogenic biofilm.[41,42] The present data cannot show when the lesions began, but the lower severity in the experimental group suggests that, although lesion initiation may be difficult to avoid, progression can be influenced by the clinical protocol.

Two mechanisms may explain the difference, although neither was measured in this study. First, dental plaque matures as a structured biofilm, with increasing metabolic activity and acid production,[43] and fixed appliances create plaque-retentive niches that raise the risk of demineralisation.[16,44] Continuous banding probably allowed a stable biofilm and prolonged acid exposure, whereas periodic removal of the band may have disrupted it. Second, fluoride exchange by glass ionomer cement enhances remineralisation and inhibits enamel dissolution,[45] but fluoride release falls with time.[46] Repeated re-banding would renew the cement layer and the fluoride release. Preventive measures such as fluoride and plaque control may not abolish demineralisation but can reduce its severity,[47,48] which is consistent with the present findings.

Earlier studies have concentrated mainly on fluoride-releasing materials.[49,50] A systematic review concluded that such materials reduce the risk of WSLs around brackets, but found no evidence that they reduce the extent of lesions that have already formed.[51] The present findings suggest that changing the clinical protocol, here by periodic re-banding,

may also influence demineralisation, by adding mechanical disruption of the biofilm to chemical prevention.

Probing depth did not differ significantly between the groups at 12 months (p=0.114). Within the control group it increased slightly from baseline to 12 months (mean difference 0.20 mm, p=0.042), whereas it remained unchanged in the experimental group (p=1.00). Because the change was small and the groups did not differ at 12 months, it should be interpreted cautiously; it is nevertheless in line with reports that bands may cause mild periodontal changes through plaque accumulation.[2,18,21,52]

Discomfort associated with re-banding was low: 80% of patients reported no or mild discomfort, and none reported a score above 3. This suggests that periodic re-banding is acceptable to patients, although the discomfort of repeated band removal should be weighed against the potential benefit.

The strengths of the study include the split-mouth design, standardised photographic documentation, ICDAS-based assessment, which is sensitive to early enamel changes, and the real clinical setting.

Limitations and Future Directions

The present pilot study provides preliminary insights into enamel demineralisation associated with orthodontic banding protocols; however, certain limitations should be acknowledged. First, the relatively small sample size may limit the generalisability of the findings and the ability to detect smaller differences between the groups, and larger studies with adequate sample sizes are required to validate the present findings. Second, the follow-up period was limited to 12 months, which may not fully capture the long-term development, progression or regression of WSLs during orthodontic treatment; studies with longer follow-up are warranted to assess the persistence and potential remineralisation of these lesions.

Third, enamel demineralisation was assessed using ICDAS, a standardised clinical scoring system that involves examiner interpretation. Although examiner calibration was performed, some degree of inter-examiner variability may remain. Future studies could incorporate objective diagnostic methods, such as quantitative light-induced fluorescence (QLF), DIAGNOdent and optical coherence tomography (OCT), alongside clinical scoring to improve the quantitative assessment of enamel changes.

Furthermore, patient-related factors, including oral hygiene practices, dietary habits, salivary composition and fluoride exposure, were not quantitatively assessed or controlled. These factors may influence the development and progression of WSLs and should be considered in future investigations. Although the split-mouth design allows comparisons within the same patient, potential carry-over effects or contamination between study sites cannot be entirely excluded.

The present study also did not include microbiological assessment of dental plaque or bacterial load around orthodontic bands. Future research incorporating microbiological analysis may provide additional insight into the mechanisms underlying enamel demineralisation. In addition, comparative clinical studies evaluating different banding materials and preventive strategies, including fluoride-releasing cements, sealants, fluoride varnishes and bioactive materials, may help identify effective approaches for reducing WSL formation. Finally, further studies should evaluate the clinical feasibility, cost-effectiveness and patient acceptability of periodic re-banding protocols before their routine clinical implementation is recommended.

CONCLUSION

Within the limitations of this pilot study, periodic removal and re-banding of molar bands was associated with less enamel demineralisation on ICDAS scoring than continuous banding over 12 months, most consistently on the buccal surface. Demineralisation was nevertheless common, so periodic re-banding should be considered an adjunct to, not a replacement for, oral hygiene and fluoride measures. Probing depth did not differ significantly between the groups at 12 months, and discomfort with re-banding was mostly mild.

Larger randomised controlled trials with longer follow-up are needed to confirm these findings. They should use objective diagnostic tools such as QLF or optical coherence tomography, assess oral hygiene, diet, salivary factors and plaque microbiology, and evaluate the cost-effectiveness of, and patient compliance with, periodic re-banding.

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