ENAMEL DECALCIFICATION IN ORTHODONTIC PATIENTS; PREVALENCE & ORAL DISTRIBUTION — A CROSS SECTIONAL STUDY

[1]HOSHANG RUMI SUKHIA, BDS, BSc, MS (Ortho)
[2]M ASHRAF AYUB, BDS, MPH, MCPS
[3]DINAZ GHANDHI, BDS, FDS RCS (Eng)

ABSTRACT

The aim of the study was to investigate the prevalence of enamel de-calcification following fixed orthodontic treatment and to discuss the various current treatment options available to avoid it. Group A (experimental) comprised a total of 47 (Male: Female Ratio 23:24) post-orthodontic treatment patients, compared to Group B (control) with a total of 49 (Male: Female Ratio 29:20) post-orthodontic patients. Complete intra-oral examination to confirm the presence or absence of clinically evident enamel white spot lesions was done in both groups following appliance removal.

Enamel decalcification showed a strong affinity with lack of oral hygiene procedures amongst the orthodontic patients. Fluoride mouthwash and toothpastes combined with proper tooth brushing techniques aids in reduction of decalcified lesions in both the sexes. Furthermore, it may prevent future complications in adult patients regarding esthetics and function.

Key words: *Enamel Decalcification, Fixed Orthodontics, Oral hygiene*

INTRODUCTION

Enamel decalcification is the one of the most common complications of post-orthodontic treatment[1]. Lack of oral hygiene or dental neglect is the major culprit [2], causing both esthetic and psychological problems for the patient. Mild post-orthodontic decalcification demonstrates a clinical color change from white to yellowish-white stains. This loss of enamel can range from minor 'white spot lesions' to actual cavitation [2-3]. Moreover, moderate post-orthodontic decalcification is characterized by yellowish-brown staining and surface roughness. In some cases, severe post-orthodontic enamel decalcification causes darker, yellowish-brown stains with ultimate loss of enamel. Furthermore, excessive consumption of chemically erosive foods such as citrus fruits and fizzy carbonated drinks may aggravate any existing decalcification during treatment[4]. In spite of various treatment options available today such as topical fluoride gels, toothpastes, mouthwashes, varnishes, acid-pumice microabrasion and esthetic restorations, enamel decalcification remains a major unpredictable complication[5].

The prevalence of white spot lesions is not unique to orthodontic patients, and can develop anywhere when oral hygiene level is neglected and plaque is allowed to accumulate. Its incidence appears to increase with age and treatment duration. Evidence of decalcification can remain even 5 years post-treatment. If left unchecked, cavitation may occur leading to caries [6].

Few investigators[6-7] in the past have linked dental neglect during orthodontic treatment regarding age, sex and distribution in oral cavity. The present study is a 3-year cross sectional study to investigate the prevalence of decalcification lesions amongst orthodontic patients following appliance removal who showed compliance with oral hygiene procedures compared to the non-compliant patients.

METHODOLOGY

A total of 96 immediate post-orthodontic treatment patients were investigated at the Jinnah Medical & Dental College, Orthodontic Department, for clinical presence of enamel decalcification. The patients were divided into 2 groups. Group A (experimental) comprised a total of 47 (Male: Female Ratio 23:24) post-orthodontic treatment patients, compared to Group B (control) with a total of 49 (Male: Female Ratio 29:20) post-orthodontic patients. As mentioned, both groups were investigated for enamel lesions following fixed appliance removal. Bracket de-bonding pliers and molar band remover pliers were utilized for all patients.

[1]Associate Professor of Orthodontics & Head of Department, Jinnah Medical & Dental College, Karachi
[2]Associate Professor & Head of Community Dentistry, Jinnah Medical & Dental College, Karachi
[3]Assistant Professor of Oral Surgery & Head of Department, Altamash Institute of Dental Medicine, Karachi
Correspondence: Dr. Sukhia Dental Surgery, Main Abdullah Haroon Rd, Saddar, Karachi
Email: hsukhia @ cyber.net.pk **Ph:** 521 8975, **Website:** www. geocities.com/pakistan_dental

The patients in this study were divided into 4 major age groups: 14-16 years, 17-19 years, 20-24 years and 25-30 years age. The mean fixed appliance treatment duration was 18.4 months. Ortho Organizer Advantage ™ No-Mix Direct Adhesive Composite system was used for bracket bonding while GC (Gold Label) corporation ™ Japan Glass Ionomer luting cement for molar banding. A wide variety of malocclusions were treated during the course. Furthermore, no removable appliances were used, and all patients selected showed no pre-treatment clinical signs of enamel decay or decalcification.

All Group-A patients were specifically advised fluoride mouthwash and fluoride toothpaste (> 1450 ppm) thrice daily during the entire duration of the treatment. Furthermore, patients were strictly instructed with a special tooth brushing technique (modified Bass Method) during the entire treatment course. Parents and guardians were instructed to routinely check and remind oral care procedures at home and to report any difficulties encountered.

On the other hand, Group-B subjects comprised routine orthodontic patients who demonstrated lack of self-motivation towards treatment, loss of interest towards oral hygiene procedures, irregular appointment schedules and appliance breakages during treatment. None of the Group-B patients had special oral hygiene methods stressed or demonstrated at beginning or during the entire orthodontic treatment duration.

The intra-oral clinical examination and diagnosis was conducted at the department utilizing dental mirror, probe and tweezers. No radiographs were used in the study.

The dentition was examined in 4 Segments;

- **ULS-**Upper Labial Segment (maxillary canine to canine across midline)
- **LLS-**Lower Labial Segment (Mandibular canine to canine across midline)
- **UBS-**Upper Buccal Segments (right & Left erupted premolars/molars)
- **LBS-** Lower Buccal Segments (right & Left erupted premolars/molars)

In our study, clinical examination was performed prior to dispatching the patient for scaling and composite removal. The extent and severity of enamel decalcification was not noted, only the presence or absence in each quadrant was checked immediately after appliance removal.

Statistical Evaluation: We used SPSS 10.0 (Statistical Package for Social Sciences) version computer program and the mean values were obtained for each parameter. One-way ANOVA was utilized to obtain data. In our study, $P < 0.05$ was considered statistically significant, while $P < 0.01$ was highly significant, followed by $P < 0.001$ as very highly significant.

RESULTS

General Distribution Parameters: As noted in **Fig 1**, males (total mean prevalence value 67.3) demonstrated more enamel decalcification lesions ($p<0.01$) as compared to their female counterparts (total mean prevalence value 32.7) in both Group A & B, respectively. Furthermore, females showed slightly more mandibular lesions (mean prevalence value 52.3) as compared to maxillary lesions (mean prevalence value 47.7), while the male subjects showed greater mandibular decalcification lesions with a mean prevalence value of 64.3 ($p<0.05$) as compared to maxillary lesions with a mean prevalence value of 35.7, respectively.

Age Distribution Parameters: As evident from **Fig 2**, Group B subjects demonstrated greater prevalence of enamel decalcification lesions as compared to Group A ($p<0.01$). Furthermore, the 14-16 years age group demonstrated the least prevalence (Group A with 18.6 mean prevalence value and Group B with 28.7 mean prevalence value), while the 25-30 years age group showed the highest decalcification lesions with Group A demonstrating a mean prevalence value of 27.3 compared to Group B ($p<0.05$) with a mean prevalence value of 57.8, respectively.

Oral Distribution Parameters: As shown in **Fig 3**, all intra-oral quadrants demonstrated decalcification lesions especially in the upper anterior and lower buccal segments. Group B showed more lesions in the lower buccal quadrant with mean prevalence value 56.7 (($p<0.01$), followed by the upper anterior segment with mean prevalence value of 45.7 ($p<0.05$), while the lower anterior segment showed the least distribution mean prevalence value of 37.4. As compared to these values, Group A demonstrated the least decalcification lesions in the lower anterior quadrant (mean prevalence value 12.6), while the upper buccal quadrants demonstrated slightly higher lesions (mean prevalence value 17.3).

Age & Sex Distribution Parameters: As noted in **Fig 4**, all age groups in our study demonstrated more prevalence in males and as compared to the females. The highest enamel decalcification lesions distribution was noted in the 25-30 years age group with males having a mean prevalence value of 37.3 ($p<0.05$) as compared to the female subjects with 33.2. As evident, 14-16 years age group demonstrated the least decalcification lesions with males showing a mean prevalence value of 12.5 compared to females with 8.66, respectively.

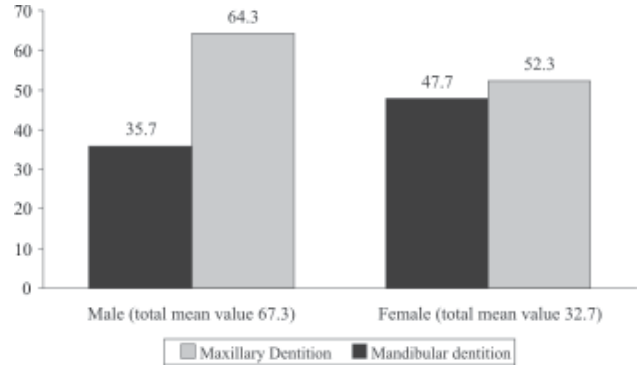

Fig 1: Mean Prevalence Distribution of Decalcification Lesion in Maxilla and Mandible related to Sex in Groups A & B

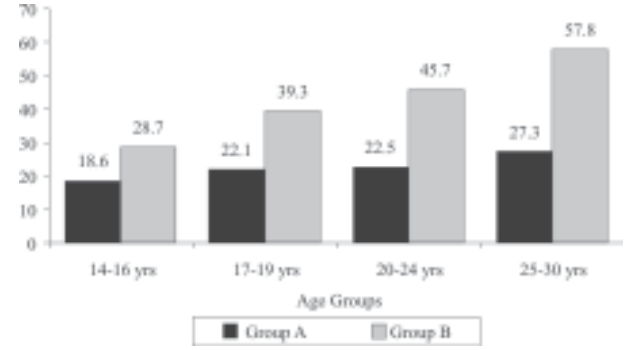

Fig 2: Mean Decalcification Prevalence Values of GroupsA & B related to Age Groups

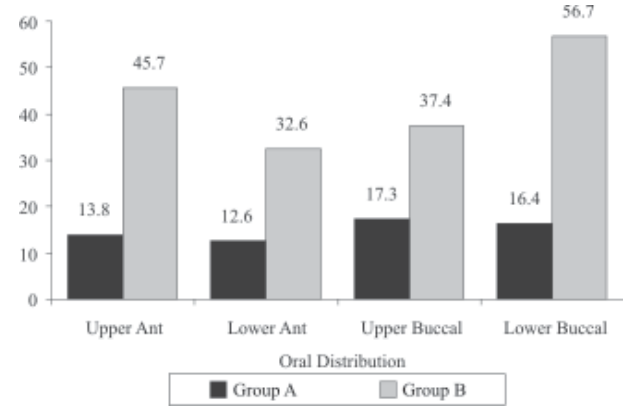

Fig 3: Mean Prevalence Distribution of Decalcification Lesions in the dentition in Groups A & B

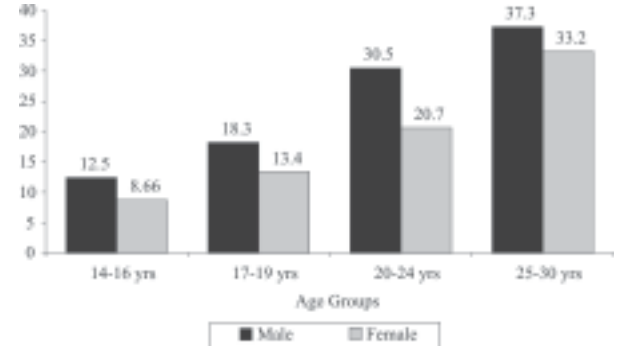

Fig 4: Decalcification AgePrevalence Related to Sex

DISCUSSION

The present cross-sectional study agrees with numerous authors [8-10] who have directly linked oral hygiene with enamel decalcification. Similarly, the objective of our study was also to investigate the clinical presence of decalcified enamel lesions developing during fixed orthodontic treatment, and furthermore, to also investigate the impact of oral hygiene in compliant and non-compliant patients regarding age and distribution in the oral cavity.

The etiology of enamel decalcification, gingivitis and ultimately periodontitis is inter-linked, as all are aggravated due to lack of oral hygiene. As mentioned by previous researchers[11-12], fixed orthodontic appliances cause marginal gingivitis which ultimately if neglected leads to periodontitis, especially during tipping and intrusion movements during treatment. This is due to deepening of gingival pockets during tipping or intrusion, causing pseudo-pocket formation by tissue bunching or higher position of tissues. If oral hygiene is neglected during this period, sub-gingival bacteria colonization initiates periodontal breakdown, plaque accumulation and eventually enamel decalcification. To confirm the relationship of oral hygiene neglect and enamel decalcification, **Zachrisson BU & Zachrisson S 1971** [13] have shown that compliant patients with effective preventive dental procedures during fixed orthodontic treatment, developed no clinically significant damage to enamel and periodontal structures.

As noted in our study, the most prevalent sites for enamel decalcification was the upper labial segment and the lower buccal segment. It agrees with previous studies [14-15] which demonstrated that the commonest site for earliest white spot lesions is the maxillary lateral incisors, followed by the mandibular premolars and molars. To confirm this, **Vivaldi-Rodrigues G & Demito CF 2006** [16] also showed more buccal segment involvement as compared to other intra-oral sites regarding decalcification. This could probably be attributed to extraction space closing loops in the lateral and canine region and elastomeric chains in the buccal segments during active space closure. Moreover, mandibular premolar and molar banding has been implicated to cause decalcification [17] as evident in our study the lower buccal segment teeth showed significant ($p<0.01$) white spot lesions after appliance removal. However, **Geiger AM 1992** [18] found the upper canines and laterals and lower canines and premolars as the most commonly affected teeth.

Regarding the age and sex distribution in our study, group B subjects demonstrated greater prevalence of enamel decalcification lesions as compared to Group A ($p<0.01$). These findings have been confirmed

by previous researchers [18-19] investigating non-compliant orthodontic patients with more dental plaque deposition and consequently enamel decalcification. As noted, the 14-16 years age group demonstrated the least prevalence, while the 25-30 years age group showed the highest decalcification lesions in Group B ($p<0.05$) with a mean prevalence value of 57.8, respectively. Furthermore, all male age groups demonstrated greater decalcification lesions as compared to the female subjects. These results agree with **Farrow ML & Newman SM 2007** [20] who also demonstrated more dominant lesions in males as compared to females, while other studies [21] have shown that enamel decalcification is more common with increasing age in adults as compared to teenage orthodontic patients in both sexes. **Artun J & Brobakken BO 1986** [22] found no sex correlation in enamel decalcification but implicated salivary factors such as pH, salivary flow and buffer capacity as etiological factors.

In the present study only fixed orthodontic appliance patients were included. However, as compared to fixed appliances, removable orthodontic appliances have not been shown to cause enamel decalcification or periodontal problems [18,20,21]. No palatal surface white spot lesions were detected in our study. However, **Geiger et.al** [18] claims more palatal white spot lesions with removable appliances. As a rule, always minimize periodontal damage before rendering any orthodontic treatment. Moreover, to avoid any litigation in the future, initial diagnosis and informed consent is essential for potential risk patients and decalcified lesions prior to commencement of treatment [23-34].

In our study, newly inducted Group-A patients were instructed with the modified bass method and domestic oral hygiene procedures were stressed and explained on study models with practical intra-oral demonstration with a newly purchased soft-bristle toothbrush. No special orthodontic toothbrush was recommended as the study focused on the efficacy of the brushing technique, rather than the toothbrush itself. It is essential to teach patients during appointments by demonstrating practically the correct brushing technique in presence of parent or guardian [23-24]. Patients were emphasized to clean behind the archwire ie. Inter-proximal areas. The "look in mirror and tell' technique [25] was stressed until appliance appears clean and shiny. In our study, all patients were advised to strictly follow this brushing technique thrice daily. **Zachrisson** [13] stated the influence of the dominant hand during brushing ie. In right-handed patients, enamel decalcification occurs on right side through less effective cleaning. No electric –toothbrush was used during this study. However, it is worth mentioning that if oral hygiene fails to show improvement, then electric or battery powered toothbrushes can also be recommended for adult orthodontic patients as the last resort. These claim to cause less abrasion and effectively remove inter-proximal plaque [26].

During our study, Group A patients used fluoride toothpastes and mouthwash during the entire treatment duration as instructed without any untoward difficulty. In our study, dual-fluoride prescription toothpaste ie. containing both sodium monofluorophosphate and sodium fluoride (greater than 1450 ppm strength) was recommended aiming to promote remineralization and increase enamel resistance during treatment. Flossing was not advised, as it tends to break brackets and damage the gingival tissues if improperly utilized [26-27]. The recommended brushing time was 3-5 minutes, however, patients were advised to brush until appliances were clean. In the past, some authors [28] have advised fluoride toothpastes without rinsing with water to decrease decalcification. Our department recommended fluoride mouthwash containing 0.05% sodium fluoride as an additional boost for oral hygiene. As we know, fluoride rinses is the treatment of choice for prevention of enamel decalcification and carious lesions during orthodontic treatment but does not aid in prevention of gingival and periodontal conditions [28-29]. Some investigators in the past [30] have recommended chlorhexidine rinses during treatment for 6-12 weeks if periodontal infection does not subside. However, in the present study, no chlorhexidine mouthwash was prescribed as it causes discoloration of any existing composite restorations and enamel over a period of time. However, other studies [31] have shown dramatic reduction in plaque and gingival bleeding with only 3 months of 0.012 percent chlorhexidine during orthodontic treatment. Most authors [32] also recommend stannous fluoride gels (SnF2) for gingivitis and decalcification prevention, but it also causes enamel discoloration in 15-20 percent cases in 3-6 months [33].

In our study, no fluoride-releasing elastomers and adhesives were used except for glass-ionomer luting cement for molar banding. **Dincer B & Erdine AM 2002** [34] have shown that GIC cements demonstrate a slow sustained fluoride release over 2-3 year period, thereby reducing enamel decalcification during fixed braces treatment. However, in our study, buccal segments were found to have decalcified lesions, which could be attributed to loose fitting and incorrect band sizes leading to food impaction. However, in the past some authors [35] have even recommended resin sealants over labial surfaces and reduced composite flash around brackets to prevent enamel decalcification.

CONCLUSION

As evident, patients demonstrating oral hygiene during fixed appliance therapy showed less prevalence for enamel decalcification as compared to non-compli-

ant patients with lack of oral health care. As noted, simple daily oral hygiene procedures have shown direct reduction of enamel decalcification. Appropriate patient selection ie. to exclude patients with poor oral hygiene, dietary advice and constant clinical monitoring during treatment may reduce enamel damage. However in the future, further long-term investigations are required regarding the severity of enamel decalcification inflicted during fixed orthodontic treatment.

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