

Prevalence of White Spot Lesions in Patients Treated with Passive Self-ligation Orthodontic Appliances: A Retrospective Study

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ABSTRACT

Introduction: White Spot Lesions (WSLs), also known as “white opacity,” are the result of the demineralisation occurring on tooth surfaces in patients undergoing fixed orthodontic treatment. In addition to the various other factors, development of WSLs can also be influenced by the type of brackets and ligation employed.

Aim: Evaluating the prevalence of WSL among patients who underwent fixed orthodontic treatment with passive self-ligation mechanotherapy.

Materials and Methods: This retrospective study was conducted using photographic records of patients who received orthodontic treatment using a passive self-ligation system at Saveetha Dental College in Chennai, Tamil Nadu, India. The records of 97 patients in the age range of 10-30 years who received orthodontic treatment using the Damon self-ligating system regardless of gender were obtained from April 2016 to April 2021. The presence of WSL was investigated retrospectively before and after treatment. Modified Gorelick’s scale was used

for scoring the lesions. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) software version 17.0 and paired t-tests were done.

Results: Data of total of 97 subjects (45 females (46.39%) and 52 males (54.63%), mean age: 17.70±5.72 years) undergoing orthodontic treatment with self-ligation brackets was included in the study. The overall prevalence percent of WSLs in the study was 71.13%. The prevalence of WSLs among females was 70.5% and in males, it was 73%. There was no statistical significance for association between gender and severity of WSLs and there was a statistical significance for association of age group and severity of WSLs in upper lateral incisors and canines ($p < 0.05$).

Conclusion: The most commonly involved teeth were upper central incisors and second premolars, and the overall WSLs incidence in subjects undergoing passive self-ligation therapy was 71.9%. No influence of the gender was noted and severe lesions were commonly noted in maxillary lateral incisors of young individuals.

Keywords: Enamel caries, Enamel demineralisation, Fixed orthodontic therapy, White opacity

INTRODUCTION

The WSLs are areas of initial enamel demineralisation seen commonly in subjects undergoing fixed orthodontic treatment [1]. Presence of fermentable carbohydrates in combination with poor oral hygiene and a variety of host factors like low salivary volume and consumption of a sugary diet can contribute to progress of these early lesions [2,3]. The presence of any appliances around the tooth surface will attract plaque and increase in the number of plaque retention sites, making tooth cleaning more difficult [4]. The incidence of WSLs in orthodontic patients varies between 2% and 96% [5,6]. The incidence and prevalence rates of WSL with fixed orthodontic treatment were 45.8% and 68.4%, respectively, according to the findings of this meta-analysis by Sundararaj D et al., [7]. According to Lucchese A and Gherlone E, significant decalcification occurred just six months after orthodontic bonding [8]. According to Julien KC et al., roughly 25% of patients developed WSL during therapy depending on fluorosis, treatment length, prior WSLs, and oral hygiene [9]. The labio-gingival region of the lateral incisors is the most common site for WSLs whereas the maxillary posterior segments are the least prevalent sites with males being impacted more than females [10].

Appliance design, notably the ligation process for archwires are other elements that influence the build-up of dental plaque [11]. Self and conventional ligation treatments have been evaluated in few published studies to see how they affect dental plaque retention and microbial flora [12,13]. The patient’s age at the start of treatment

and oral hygiene were also key factors for the development of WSLs according to Richter AE et al., [14]. Prolonged treatment duration has an effect on the incidence of WSLs [15]. Detection of WSLs qualitatively and quantitatively can be done with various methods [16-25].

Damon passive self-ligation brackets are used very commonly in practice to treat borderline cases without involving extraction of teeth [26]. It is important to assess whether the bracket design, method of ligation and treatment protocols influences the incidence of WSLs, hence this study was proposed. Existing literature reports on comparison of WSLs prevalence between conventional and self-ligation [27,28]. The present study was aimed to study the WSLs prevalence in subjects treated with passive self-ligation and also report on individual teeth prevalence and other factors like age and gender which can influence the prevalence.

MATERIALS AND METHODS

This retrospective study was conducted using photographic records of patients who received orthodontic treatment using a passive self-ligation system at Saveetha Dental College in Chennai, Tamil Nadu, India. The time period for which data was considered was between April 2016 to April 2021 and the time period for planning and execution of data analysis and interpretation was between June 2021 to September 2021. Ethical clearance to conduct this study was obtained from the scientific Review Board of the hospital (IHEC/SDC/ORTHO-2007/22/524).

Inclusion criteria: Complete data of patients of both gender from 10-30 years of age undergoing orthodontic treatment with self-ligation brackets, with good quality standardised photographs of both before and after extraction was included in the study.

Exclusion criteria: Incomplete records, retreatment cases, subjects treated with other fixed orthodontics appliances, enamel hypoplasia, WSLs before treatment fluorosis, stains and demineralisation before orthodontic treatment were excluded from the study.

Sample size calculation: It was done using data from a previous research, and a sample of 97 people was obtained with a significance of 0.05 and 95% power [9]. The study sample comprised 97 subjects in the age category of 10-30 years who met the selection criteria.

Study Procedure

The presence of WSLs was investigated retrospectively in photographs of patients taken before and after treatment. This retrospective study involved records of patients treated with Damon self-ligation appliance in the age range of 10-30 years at T₀ (pre-treatment). As oral hygiene maintenance and incidence of WSLs may differ between children and adults [29], the study subjects were divided into two age groups: 10-17 years (children) and 18-30 years (adults). The average treatment time was 18±3 months and the incidence of WSLs was noted only in all erupted permanent teeth which were bonded in the course of treatment. So if a patient's treatment begun at 10 years, the incidence of WSLs was recorded only at the end of treatment (T1) and only permanent teeth were analysed at T1.

All photographs were taken by a single professional photographer who was attached with the department and who took photographs for all ortho patients using a DSLR camera (Canon 600D, Tokyo, Japan), 90 MM Tamron macro lens and Godox ring flash. Camera settings were as follows, Aperture-f/25, Shutter Speed-1/200 and ISO-100. For the scoring WSLs, modified Gorelick's scale by Årtun J and Brobakken BO was used [29]. Score 0-no white spot formation, Score 1-WSLs involving less than one-third of the vestibular enamel surface area outside the area covered by bracket and bonding material, Score 2-WSLs involving more than one-third but less than two-thirds of the vestibular enamel surface area in question and Score 3-WSLs involving more than two-thirds of the vestibular enamel surface area in question.

Examination, scoring and calibration of WSLs was done by 1 examiner (KR) and to check the intra-operator reliability, the same operator examined 10 patient records randomly again after a week. Then intra-rater reliability test value was 0.813 indicating significant agreement with Kappa statistics test.

STATISTICAL ANALYSIS

The scores were tabulated and statistical analysis was performed using SPSS software (version 17.0 SPSS. Inc., Chicago, IL, United States of America). Chi-square test was done to check the association of both age groups and gender for severity of WSLs.

RESULTS

Photographs of a total of 97 subjects undergoing orthodontic treatment with self-ligation brackets 45 females (46.39%) and 52 males (54.63%) in the age group of 10-17 years {63 subjects (64.94%)} and 18-30 years {34 subjects (35.05%)} were examined for WSLs.

[Table/Fig-1] depicts the gorelicks' scoring for severity of WSLs and Chi-square association p-values for both genders. [Table/Fig-2] depicts Gorelick's scoring for severity of WSLs and Chi-square association p-values for both age groups 10-17 years and 18-30 years. A very high overall prevalence of 69 (71.13%) was noted. Maxillary central incisors and second premolar teeth were most commonly affected with WSLs; there was no statistical significance

for association between gender and severity of WSLs. Upper first premolars were least commonly affected in females and most commonly affected teeth were second premolars. In females, maxillary lateral incisors were most severely affected with WSLs. In males, maxillary central incisors were most commonly affected teeth, mandibular lateral incisors reported with mild WSLs, mandibular central incisors with moderate and mandibular second premolars had severe WSLs but none of these were statistically significant. The association between age group and severity was significant for upper laterals and canines (p-value <0.05). Maxillary lateral incisors

| Tooth type | | Teeth evaluated | Score 0 | Score 1 | Score 2 | Score 3 | p-value |
|-----------------------------|---|-----------------|---------|---------|---------|---------|---------|
| Central incisor | F | 90 | 24 | 37 | 16 | 13 | 0.35 |
| | M | 104 | 16 | 32 | 42 | 14 | |
| Lateral incisor | F | 90 | 26 | 5 | 19 | 40 | 0.94 |
| | M | 104 | 26 | 35 | 27 | 16 | |
| Canine | F | 90 | 37 | 20 | 8 | 25 | 0.88 |
| | M | 104 | 38 | 32 | 28 | 6 | |
| 1 st premolar | F | 90 | 41 | 9 | 15 | 25 | 0.44 |
| | M | 104 | 24 | 27 | 35 | 18 | |
| 2 nd premolar | F | 90 | 15 | 27 | 23 | 25 | 0.89 |
| | M | 104 | 24 | 31 | 23 | 26 | |
| L. central incisor | F | 90 | 21 | 26 | 17 | 26 | 0.54 |
| | M | 104 | 23 | 29 | 27 | 25 | |
| L. lateral incisor | F | 90 | 27 | 19 | 28 | 16 | 0.57 |
| | M | 104 | 43 | 17 | 23 | 21 | |
| L. canine | F | 90 | 18 | 11 | 31 | 30 | 0.68 |
| | M | 104 | 36 | 22 | 29 | 17 | |
| L. 1 st premolar | F | 90 | 33 | 17 | 18 | 22 | 0.26 |
| | M | 104 | 27 | 32 | 21 | 24 | |
| L. 2 nd premolar | F | 90 | 23 | 42 | 13 | 12 | 0.41 |
| | M | 104 | 23 | 20 | 14 | 47 | |

[Table/Fig-1]: The Modified Gorelick's scoring for severity of White Spot Lesions (WSLs) and Chi-square association p-values for both genders.

| Tooth type | Age groups | Teeth evaluated | Score 0 | Score 1 | Score 2 | Score 3 | p-value |
|-----------------------------|------------|-----------------|---------|---------|---------|---------|---------|
| Central incisor | 10-17 | 126 | 33 | 36 | 29 | 28 | 0.08 |
| | 18-30 | 68 | 8 | 25 | 18 | 17 | |
| Lateral incisor | 10-17 | 126 | 37 | 22 | 27 | 40 | 0.02* |
| | 18-30 | 68 | 27 | 4 | 21 | 16 | |
| Canine | 10-17 | 126 | 21 | 42 | 32 | 31 | 0.03* |
| | 18-30 | 68 | 16 | 11 | 22 | 19 | |
| 1 st premolar | 10-17 | 126 | 47 | 19 | 25 | 35 | 0.29 |
| | 18-30 | 68 | 19 | 22 | 18 | 9 | |
| 2 nd premolar | 10-17 | 126 | 44 | 18 | 37 | 27 | 0.69 |
| | 18-30 | 68 | 21 | 8 | 28 | 11 | |
| L. central incisor | 10-17 | 126 | 13 | 34 | 44 | 35 | 0.34 |
| | 18-30 | 68 | 2 | 19 | 37 | 10 | |
| L. lateral incisor | 10-17 | 126 | 9 | 52 | 28 | 37 | 0.27 |
| | 18-30 | 68 | 9 | 21 | 26 | 12 | |
| L. canine | 10-17 | 126 | 36 | 7 | 38 | 45 | 0.31 |
| | 18-30 | 68 | 14 | 7 | 42 | 5 | |
| L. 1 st premolar | 10-17 | 126 | 4 | 34 | 64 | 24 | 0.55 |
| | 18-30 | 68 | 4 | 21 | 6 | 37 | |
| L. 2 nd premolar | 10-17 | 126 | 27 | 41 | 50 | 8 | 0.28 |
| | 18-30 | 68 | 8 | 14 | 13 | 33 | |

[Table/Fig-2]: The Modified Gorelick's scoring for severity of WSLs and Chi-square association p-values for both age groups 10-17 years and 18-30 years.

had severe WSLs and canines had mild WSLs in the 10-17 years age group (p -value >0.05).

DISCUSSION

Passive self-ligation excludes the use of elastomeric modules or ligature wires leading to better oral hygiene maintenance [30], which in turn may influence the incidence of WSLs. Hence, this study was proposed to report the influence of ligation on WSL incidence. All subjects included in this study were treated with a passive self-ligation system without extracting teeth and were

The present study does not report a comparison of self-ligating brackets with conventional ligation brackets as reported by Tiwari A and Jain RK [32]. In this study, a comparison of WSLs formation between self-ligating brackets and conventional pre-adjusted straight wire brackets was attempted and they found that enamel demineralisation occurred regardless of the technique of ligation [32]. They also found that the level of oral hygiene of the patients rather than the type of bracket or ligation used was the most important factor in the development of WSLs [33]. Comparative evaluation of similar studies from the literature has been done in [Table/Fig-3] [6,15,27,32,34].

| S. No. | Author's name and year | Place of study | Number of subjects | Age considered | Parameters compared | Conclusion |
|--------|---------------------------|----------------|--------------------|--------------------|--|--|
| 1 | Akin M et al., [27] | Turkey | 1696 | 10-18 years | WSLs prevalence between conventional brackets and self-ligation brackets | -There were 3% cavitated lesions, 3% newly developed WSLs, and 20% severely developed WSLs. -Sex-related factors were not linked to lesion development. |
| 2 | Khalaf K, [15] | United Kingdom | 45 | 15-17 years | WSLs incidence, severity, and site are all influenced by several factors for conventional brackets. | -White Spot Lesions (WSL) has appeared in 42% of cases. -Site-Mandibular anterior teeth affected. -Maxillary lateral incisors and canines were most affected |
| 3 | Mirzahi E [6] | South Africa | 796 | 10-16 years | The frequency and severity of opacities in the enamel | New areas of enamel demineralisation were developed as a result of multibanded appliances. |
| 4 | Boersma JG et al., [34] | Amsterdam | 62 | 12 years and above | WSLs prevalence and severity | 50 and 76% of subjects were considered to be at high to extreme caries risk |
| 5 | Tiwari A and Jain RK [32] | India | 19 | 20-35 years | Comparison of enamel demineralisation between self-ligation and conventional bracket | No difference in enamel demineralisation between both the groups. |
| 6 | Present study | India | 97 | 10-30 years | WSLs prevalence with passive self-ligation, individual teeth prevalence and other factors like age and gender influence the prevalence | Overall prevalence is 71.13%. No gender related influence and younger patient developed severe WSLs in upper lateral incisors. |

[Table/Fig-3]: Comparative evaluation of previous studies with present study [6,15,27,32,34].

evaluated for presence and severity of WSLs on photographs employing the modified Gorelicks scale. A very high overall prevalence of 71.13% was noted. The most commonly involved teeth were maxillary central incisors and second premolars and there was no association between severity of WSLs and the gender of the subjects. Severe WSLs were commonly seen in subjects in the younger age group.

Akin M et al., evaluated the occurrence of WSLs in patients treated with self-ligation and conventional ligation systems using Gorelick's original scale on photographs. In their study, subjects on self-ligation brackets had a WSL prevalence of 46% whereas in the present study, it is 71.13%. This disagreement can be due to differences in sample size, oral hygiene maintenance and duration of treatment. They reported that gender had no effect on the development of the WSLs score during therapy in the self-ligation group which was in agreement with the present study. They reported significant associations between development of new WSLs, age at treatment starting and oral hygiene scores but these parameters were not assessed in the present study [27].

The present study reported on WSLs incidence in individual teeth rather than just reporting on overall prevalence as given by Akin M et al., Verma P and Jain RK had reported WSLs prevalence of 21.34% in subjects treated for 12-24 months with conventional ligation [27,28], but in the present study, a higher prevalence rate of WSLs for passive self-ligation therapy treated for a similar duration was noted. According to a study by Khalaf K, the occurrence of WSLs in subjects undergoing orthodontic treatment with conventional ligation was more in maxillary anterior teeth than mandibular anteriors, the maxillary canines and lateral incisors were the most severely affected teeth [15] and these findings are in consensus with the present study as the authors noted most severe lesions in maxillary lateral incisors when using passive self-ligation. Chapman JA et al., reported that the prevalence of WSLs was higher in the younger age group which was in agreement with the present study [31].

Limitation(s)

Because this was a retrospective study, it was impossible to examine factors that could have influenced the study's results, such as all patients' dental hygiene maintenance. Furthermore, each patient's oral hygiene practices would have been unique, making it impossible to examine them.

CONCLUSION(S)

An overall prevalence of WSLs noted in subjects undergoing orthodontic treatment with passive self-ligation system was 71.13%. Maxillary central incisors and 2nd premolar teeth were most commonly affected with WSLs. No gender related differences were noted and younger individuals developed severe WSLs in upper lateral incisors. Long-term prospective research with uniform oral hygiene regimens, age groups, genders, and orthodontic treatment duration can be planned in the future.

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