Original Article

WHITE SPOT LESIONS IN ORTHODONTIC PATIENTS PART I: FREQUENCY AND PATTERN OF DISTRIBUTION

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ABSTRACT

Objective: *To determine the frequency and pattern of white spot lesions developed during orthodontic therapy in a sample of orthodontic patients*

Materials and Methods: *This cross-sectional study was designed to compare pre-treatment and post-treatment digital photographs of patients having undergone orthodontic therapy to determine the presence or absence of enamel decalcification in the form of white spot lesions. The distribution of the white spot lesions was also recorded with reference to the tooth type, as well as its location on a particular tooth. Data were analyzed using SPSS (version 11.5) where the means and frequencies were computed.*

Results: *The study sample consisted of 60 orthodontic patients. Out of these, 14 (23.3%) were males and 46 (76.7%) were females with male to female ratio of 1:3.3. The mean age was 14 years and 5 months and the mean fixed appliance treatment duration was 2 years and 9 months. The frequency of White Spot Lessions according to the total number of patients affected was 75%, whereas according to the number of total teeth affected was 19%. The upper lateral incisors were the most commonly affected teeth (78.3%), followed by the lower 1st permanent molars (55%), the upper central incisors (43%) and upper canines (40%). According to the type, the chalky-white White Spot Lessions were more common (76.2%) as compared to the brown lesions and cavitations. According to the site, the upper anterior teeth showed a more central occurrence as compared to the upper posterior and lower teeth, which were mostly affected in the gingival third of the crown.*

Conclusion: *Out of 60 patients, 75% were affected by White Spot Lessions while the overall number of teeth affected was 19%. The most commonly affected teeth were upper lateral incisors (78.3%) while chalky white type White Spot Lessions were more common (76.2%). Middle third of the crown of upper anterior teeth was the most commonly affected site.*

Keywords: *White spot lessions, Orthodontic patients, Lateral incisor, Brown lessions.*

INTRODUCTION

The Hippocratic Oath is a pledge of doing no harm to the patient, yet medical and dental treatments are often associated with certain iatrogenic effects. One such risk in orthodontics is the development of white spot lesions in association with fixed appliance therapy. White spot lesion is defined as a "sub-surface enamel porosity from carious demineralization that presents itself as a milky-white opacity when located on smooth surfaces."[1]

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Although enamel is the hardest structure in the human body, it is susceptible to demineralization. Dental caries is caused by specific types of acid-producing bacteria that cause damage in the presence of fermentable carbohydrates.[2] The mineral content of teeth is sensitive to increased pH from the production of lactic acid. When the pH at the surface of the tooth drops below 5.5, demineralization proceeds faster than remineralisation, leading to a change in the quantity and quality of the tooth's mineral.[3] As an early indicator of the initiation of the caries process is the appearance of a chalky white spot on the surface of the enamel, the site is termed as a 'white spot lesion' (WSL). If the lesion continues to demineralise, it can eventually turn into a cavitation, where the lost tooth structure cannot be regenerated.

Since oral hygiene maintenance is especially challenging with fixed appliances, the demineralization of enamel is an incessant threat and hence the WSL in the orthodontic population take on a characteristic pattern. In orthodontic patients, WSL are often seen under loose bands, around the periphery of the bracket base, and in areas that are difficult to access with a toothbrush.[4] With fixed mechanotherapy, the enamel underneath orthodontic brackets is protected from plaque and does not change in appearance. Demineralization of the enamel surface adjacent to fixed appliances however may arise as a consequence of orthodontic treatment where the patient fails to maintain good oral hygiene or the clinician fails to provide an environment which is conducive to oral hygiene maintenance. Once the braces are removed, the WSL outlining the bracket becomes visible, and can be a reason of concern for both the orthodontist as well as the patient as it not only compromises the enamel structure, but also spoils the cosmetic appearance of the tooth involved.

The orthodontic population is known to have more WSL than non-orthodontic patients.[5] Different studies have shown that orthodontic patients not only have an increase in the volume of dental plaque with treatment, but also a lower pH of the plaque as compared to non-orthodontic patients.[6] The orthodontic literature has quoted a variable incidence of WSL, reportedly affecting from 50% to 97% of patients treated with fixed appliances.[7] It has been suggested that health care providers record the extent and severity of WSL through intra-oral photographs for the purpose of documentation, comparison and patient education.[3] As the sequelae of WSL can result in irreversible damage to the tooth structure and aesthetics, it is imperative for clinicians to be aware of the prevalence of such enamel decalcifications in their patients along with knowledge of the tooth types and tooth sites which are most commonly affected, as the accurate evaluation of such lesions is important to implement early prevention and/or treatment.

To date, no local studies on the development of WSL in orthodontic patients exist in the literature. Consequently, this study was designed to determine the frequency and pattern of white spot lesions (WSL) developed during orthodontic therapy in a sample of orthodontic patients being treated at a tertiary-care hospital in Pakistan.

MATERIALS AND METHODS

This cross-sectional study was carried out at the orthodontic clinics of the Aga Khan University Hospital (AKUH), designed to compare pre-treatment and post-treatment digital photographs of patients having undergone orthodontic therapy to determine the frequency and pattern of white spot lesions. Patients having completed fixed appliance mechanotherapy at AKUH, with availability of pre- and post-treatment intra-oral digital photographs of good diagnostic quality were included in the study, where as patients having enamel hypoplasia, fluorosis or single-arch treatment were excluded, as were those cases that were started outside AKUH.

Pre- and post-treatment intra-oral photographs of 60 patients meeting the study criteria were edited using Microsoft® Office Picture Manager (2006), where the brightness levels of each photograph were adjusted to eliminate the effect of the flash. The midtone for the photograph was adjusted by eliminating the effect of the light colours for better visibility of the enamel surface of each tooth. Once the effect of the flash was removed, the WSL, if any, were clearly delineated.

The frequency and pattern of WSL distribution were recorded on a specially designed data collection form with reference to the tooth involved, location on a particular tooth (incisal, middle or gingival third) and WSL type (chalky-white, brown or cavitation). Data were analyzed using SPSS (version 11.5) where the means and frequencies were computed.

RESULTS

The study sample consisted of 60 orthodontic patients. Out of these, 14 (23.3%) were males and 46 (76.7%) were females with male to female ratio of 1:3.3. The mean age was 14 years and 5 months. The mean fixed appliance treatment duration was 2 years and 9 months, and the treatment type was divided as non-extraction (75% cases), extraction (20% cases) and orthognathic surgery (5% cases).

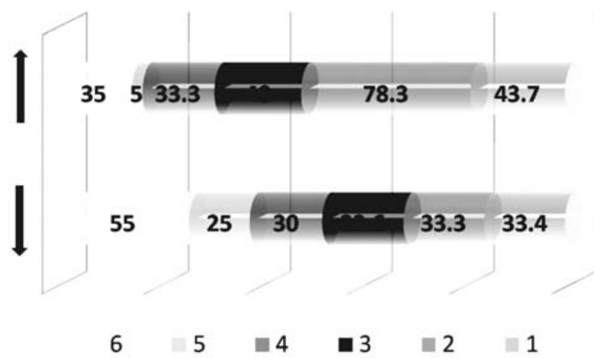
Regarding the occurrence of WSL, the results showed a total of 75% of orthodontic patients as being affected. However, according to the total number of individual teeth, it was seen that only 274 (19%) of the 1440 teeth analyzed were affected (Table 1).

With reference to the frequency of WSL, it was seen that the upper lateral incisors were the most

commonly affected teeth (78.3%), followed by the lower 1st permanent molars (55%), the upper central incisors (43%) and upper canines (40%) as seen in Figure 1.

Table 1: Occurrence of WSL in Orthodontic Patients

Presence of WSL:	Yes	No
Patients affected N=60	45 (75%)	15 (25%)
Total teeth affected n= 1440	274 (19%)	1166 (81%)



Tooth Number

↑ N= 45 Patients n= 274 Teeth
↓ = Maxillary teeth = Mandibular teeth

Fig. 1: Frequency (%) of WSL with regards to tooth type

Regarding the pattern of WSL, it was noted that according to the type, the chalky-white WSL were more common (76%) as compared to the brown lesions and cavitations (Table 2). According to the site, the upper anterior teeth showed a more central occurrence as compared to the upper posterior and lower teeth, which were mostly affected in the gingival third of the crown (Table 3).

DISCUSSION

White spot lesions have been termed as the most important iatrogenic effects of orthodontic fixed appliance therapy[8]. Since it is the orthodontist's responsibility to avoid or limit the development of such lesions during orthodontic therapy, it is of utmost importance to have an insight into the frequency and pattern of distribution of WSL in the orthodontic population.

Research in development of WSL due to orthodontic treatment has shown that more than 50% of

Table 2: Distribution of WSL Types

WSL Type	Teeth (n=274)	Percentage
Chalky-white	208	76
Brown	42	15.4
Cavitation	24	8.6

N= 45 patients
n= 274 teeth

Table 3: Distribution of WSL sites

Tooth No.	Gingival (%)	Middle (%)	Occlusal (%)
UR6	89	11	x
UR5	100	x	x
UR4	36.1	45.3	18
UR3	14.1	78.5	4.3
UR2	34.6	50.1	15.5
UR1	30.5	60.5	7.7
UL1	38.2	61.3	x
UL2	19.1	52.3	28.5
UL3	10.2	79.6	10.2
UL4	33.3	55.3	11.3
UL5	x	x	x
UL6	63.9	27.3	9.3
LR6	76.7	6.0	17.7
LR5	100	x	x
LR4	100	x	x
LR3	98.3	14.3	x
LR2	55.3	44.6	x
LR1	49.7	40.1	10.2
LL1	40.1	49.7	10.2
LL2	36.6	54.6	9.3
LL3	53.9	46.1	x
LL4	89.8	10.2	x
LL5	100	x	x
LL6	62.5	31.1	6.4

N=45 patients
n= 274 teeth
x = No WSL noted

subjects may experience an increase in the number of WSLs with fixed mechanotherapy[9]. A recent study confirmed the risk, with about 50% of the patients developing one or more WSLs during treatment, and 5.7% of the teeth being affected[10]. Boersma et al[11] reported an almost double frequency, with 97% of their patients developing WSLs during orthodontic mechanotherapy, and 30% of the teeth studied being affected. The reason for such high figures could be due to the fact that Boersma and co-workers used more advanced detection techniques like quantitative light-induced fluorescence (QLF) rather than studying the teeth using visual scales, as in most other studies.

Our study revealed a frequency between the extremes of values reported for WSL in the literature, with 75% of the patients included in the study showed demineralization of the enamel surface. Regarding the total number of teeth involved in enamel demineralization, 19% or 274 teeth out of a total of 1440 teeth analyzed were affected with WSLs. These figures revealed that although the total number of teeth affected by WSLs was not too high, a significant chance exists that 3 out of 4 patients undergoing fixed appliance therapy will develop a WSL affecting at least one tooth, compromising the quality and quantity of tooth enamel.

Regarding the pattern of WSL distribution, Ogaard[7] as well as Gorelick et al[12] have reported enamel demineralization to commonly involve the maxillary anterior teeth as well as 1st molars. In accordance with their results, our study at AKUH also showed a higher preponderance for maxillary incisor teeth and 1st molars to be affected by WSLs. The tooth showing an almost alarming rate of involvement was the maxillary lateral incisor, being affected in 78.3% of the patients with WSLs. The maxillary central incisor and maxillary canine teeth also showed greater involvement, being affected in 43.7% and 40% cases respectively, where as the 1st molars were affected in 55% of patients having WSLs.

The development of WSLs on 1st molars may be attributed to loose fitting bands or improper hygiene and brushing techniques at the back of the mouth. However, what may be puzzling to the orthodontist is the high level of involvement of the maxillary anterior teeth, where one would expect better hygiene measures due to the simple fact that there is far greater accessibility for brushing, as well as the impact on aesthetics that the teeth in the front of the mouth should have. Arneberg et al [13] proposed a plausible explanation for these perplexing values, as they showed in their study that the lowest pH was observed in the dental plaque of bonded maxillary incisors, most likely due to slow salivary clearance.

With reference to the most common site of WSL development on a tooth, Ogaard[7] in his study showed the predilection of the gingival-third for enamel demineralization. The current study showed similar results for WSLs on posterior teeth where the gingival-third was commonly affected, however, the anterior teeth mainly showed a higher incidence of WSL in the middle-third of the crown. The logic behind these results proposes the greater involvement of posterior teeth in the gingival-third due to difficulty in brushing and subsequent plaque retention in these areas especially if the brackets are bonded more gingivally, while the middle-third region in the anterior teeth corresponds to the position of the bracket base on these teeth, with adjacent enamel being demineralised.

Robertson Davies said, "The eyes see only what the mind is prepared to comprehend". For the clinician to keep a sharp eye out for potential problems arising during the course of treatment in order to avert undesirable results for the patient as well as legal issues, it is the ethical duty of every health care professional to recognize the risk factors involved with different treatment options, and prevent or limit the adverse effects one may anticipate. In order to avoid the iatrogenic enamel demineralization one may encounter so frequently with orthodontic therapy, it is imperative that stricter oral hygiene measures be implemented, with proper tooth-brushing techniques, fluoride toothpastes and mouth rinses being advised initially, and followed up on at every appointment.

CONCLUSIONS

- A high number of patients were affected by WSL.
- The overall number of teeth affected was 19%
- The most commonly affected teeth were the Upper lateral incisors
- The chalky-white type of WSL was more common
- The most commonly affected site was the middle third of the crown of Upper anterior teeth.

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