Do various degrees of tooth decalcification affect orthodontists’, general dentists’ and laypersons’ ratings of smile esthetics?

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ABSTRACT

Objectives: To compare the effect of various degrees of decalcification after orthodontic treatment (white spot lesions) on orthodontists’, general dentists’, and laypersons’ ratings of smile esthetics.

Materials and Methods: Eight photographs representing incrementally altered tooth decalcification lesions of maxillary anterior teeth ranging from mild to severe were shown randomly to the study participants. Photographs were rated by a matched sample of orthodontists (N = 42), general dentists (N = 52), and laypeople (N = 58). A visual analogue scale (VAS) was used to assess perceptions of smile esthetics.

Results: The three groups of raters could distinguish between different decalcification levels. Raters gave more negative scores as the decalcification level increased.

Conclusions: The three groups of raters were able to distinguish between various degrees of decalcification lesions. General dentists were the most critical of all groups when rating decalcification lesions. (Angle Orthod. 2020;90:405–410.)

KEY WORDS: Decalcification; Perception; Smile esthetics; Laypeople; Professional dentists and orthodontists

INTRODUCTION

Tooth color is one of the main esthetic components that influence how people react and perceive the smile. Decalcifications (white spot lesions, WSL) are one of the common adverse effects of fixed orthodontic appliance treatment ranging from mild white opaque lesions to brown stains and pitting of enamel that may have an undesirable effect on smile esthetics. The incidence of decalcification after orthodontic treatment ranges from 4% to 96%. Color changes due to enamel defects such as severe fluorosis and WSL have been reported to have negative effects on oral health-related quality of life.

Recently, there has been increased interest in the perception of tooth color change due to developmental and environmental lesions. Perception of tooth color changes is a complex interaction of various human and physical properties of the dental and oral structures. Studies on smile esthetics have focused on analyzing different components such as midline coincidence, gingival display, crown length and width, incisor angulation, and gingival esthetics. The sensitivity of detection of these components varies between dental professionals and laypeople and may be influenced by many factors such as race, culture, education, and personal experience. Although tooth color was ranked among the most noticeable dental features by Kokich et al., there is sparse literature on the impact of tooth color changes due to decalcification lesions on the perception of both dental professionals and laypeople. Investigations that have looked at tooth color changes due to decalcification lesions used both qualitative and quantitative means to evaluate these lesions. Most clinical studies have used photographic techniques to study prevalence and assessment of enamel color lesions.

There are only a few studies investigating associations between enamel defects and esthetic concerns from laypersons’ perception. These studies indicated that both laypeople and dental professionals can...
distinguish between different levels of enamel defects. Maxfield et al. assessed the level of awareness of patients, parents, and professional orthodontists and general dentists toward the development and prevention of WSL. All observers agreed that decalcification lesions made the appearance of teeth worse. The purpose of the present study was to compare the effect of various degrees of decalcification after orthodontic treatment on perceptions of laypeople and professionals of smile esthetics.

MATERIALS AND METHODS

Approval to conduct this investigation was obtained from the Internal Review Committee of the Deanship of Academic Research at the University of Jordan. A frontal colored photograph of a posed smile of a young female with ideally aligned teeth was taken with a digital camera (Nikon, New York, USA) by a professional medical photographer in a standardized room with fixed distances of subject and mounted camera. The photograph was cropped to show only the mouth area, and the chin and nose were removed. The photograph showed a standard view of the labial surfaces of the anterior teeth, with nonretracted lips placing the teeth in their natural context. The original posed smile photograph was modified using commercial image processing software (Adobe Photoshop Version 9, San Jose, Calif).

The smile was altered incrementally by introducing decalcification lesions in varying degrees of severity from very mild white opacities to brown staining and pitting of the enamel. For each photograph, the location, color, size, and shape of the decalcification lesions were introduced to simulate actual enamel lesions due to decalcification around orthodontic brackets. The lesions were chosen from original photographs of individuals with decalcification lesions. The decalcification lesions were introduced to all four maxillary incisors. In total, eight alterations were introduced in a similar fashion to the Developmental Defects of Enamel Index (Figure 1). The Developmental Defects of Enamel Index allows recording of the type (opacity, hypoplasia, discoloration), number (single and multiple), demarcation (demarcated and diffuse), and location of defects.

Each of the eight photographs representing severity levels of decalcification was given a two-letter reference code. Photos were then randomly allocated into a three-page booklet. The first two pages had four photos each: three decalcification photos and one photo of normal dentition as a control. The third page of the booklet had three photos: three decalcifications and the control.

Raters consisted of three groups: orthodontists, general dentists, and laypeople. The orthodontists were selected randomly from a list of all members of the Jordanian Orthodontic Society (JOS). The total number of active members of the JOS was 150 orthodontists. A sample of 50 were chosen and contacted to participate in this study. General dentists were chosen randomly from a list of all members of the Jordanian Dental Association. A sample size of 50 was selected to match the number of the orthodontists. The laypeople group consisted of 50 nondental trained teachers, businessman, office clerks, etc. The survey was first sent out to 50 orthodontists, and only 45 responded. To account for possible nonresponse, a larger sample size was used for general dentists and laypersons. Each rater was contacted by one of the researchers and the general purpose of the study was explained in a standardized manner.

Raters were asked to use a visual analogue scale of 50 mm to rate their perceptions of esthetics of the eight photographs with zero representing least attractive and 50 representing most attractive. Each rater was asked to mark a point on the VAS under each photograph. A digital caliper was used to measure the distance between the mark on the VAS and zero to the nearest 0.01 mm. In addition, all raters were asked to record their gender and age, and general dentists and
Orthodontists were asked to record number of years in practice.

Statistical Analyses

Analysis of data was conducted using SPSS version 16.0, (SPSS Inc., Chicago, Ill). Univariate analysis of variance with the independent variable “group” and the dependent variable age to test for age differences were carried out for the three groups. A chi-squared test was performed to test for gender distribution among the three groups. An independent sample t-test was used to test for differences in the number of years in practice between the general dentist and orthodontist groups. A two-way repeated measures analysis of variance (ANOVA) was used to test for differences among the eight discrepancy levels of decalcification lesions among the three groups. In addition, Tukey’s post hoc comparisons across all pairs of interaction levels and all pairs of groups were performed.

RESULTS

Five orthodontists and two general dentists declined to participate in the study. Three questionnaires were not included for both the orthodontist and laypeople groups due to missing data. The final sample size was 42 orthodontists, 52 general dentists, and 58 laypeople (Table 1). The response rate was 89% for orthodontists, 96% for general dentists, and 94% for laypeople. There were no statistically significant differences among the gender distributions in the three groups of raters (P = .074). Table 1 shows the mean numbers of years in practice for the professional groups. The mean experience in practice for orthodontists and general dentists was 13 and 8 years, respectively. The results of independent sample t-test showed no significant difference in the number of years in practice between the general dentist and orthodontist groups (P = .063). The results of ANOVA with years of professional experience as the independent variable and esthetic perception of all eight photographs as the dependent variable showed no statistically significant differences for all rated photographs (P > .05).

Figure 2 shows mean scores for appearance of decalcification lesions for the three groups of raters. Results demonstrated that the three groups of raters could distinguish between different decalcification levels: decalcification scores of 1 were perceived as esthetically pleasing among all raters, but raters gave more negative scores as the decalcification levels increased from 2 to 8 (Table 2).

Table 2 shows the mean and standard error of ratings for the three groups of raters for all decalcification scores. A one-way ANOVA showed that overall scores of dentists were significantly lower (worse) than orthodontists and laypeople (P < .01). There were no significant differences between raters when rating decalcification scores 1 and 2 (P > .05). Laypersons and dentists were more critical than orthodontists at rating decalcification scores 3, 5, and 8 (P < .05). Dentists were more critical than laypeople and orthodontists at rating decalcification scores 4, 6, and 7 (P < .05).

Table 2 also shows the overall mean and standard error scores of the appearance of decalcification lesions for each group of raters. Results showed that general dentists were the most sensitive of all groups when comparing overall rating of the decalcification lesions (P < .05), indicating that general dentists perceived decalcification more negatively than the other two rater groups.

DISCUSSION

The purpose of the present study was to compare the esthetic perception of altered variations in tooth color due to decalcification among orthodontists, general dentists, and laypeople. This was the first study that objectively assessed perception of esthetics using incrementally digitally altered degrees of decalcification of anterior teeth.

Views used in the present study showing the lower part of the face eliminated any distraction, which might have arisen from other facial features.24 Most of the investigations on smile esthetics used photographs showing lower face views of altered smile variables.8,10,25 Few studies used full face views to depict various smile characteristics.5,26 However, there was no evidence to indicate which view of the face would be more appropriate.27,28 Most clinical studies have used

### Table 1. Demographic Data for the Three Groups of Raters

<table>
<thead>
<tr>
<th>Number</th>
<th>Response Rater (%)</th>
<th>*Gender</th>
<th>**Mean Age Years (SD)</th>
<th>Age Range</th>
<th>***Years in Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthodontists</td>
<td>42</td>
<td>89</td>
<td>38 (90)</td>
<td>4 (10)</td>
<td>37.90 (8.56)</td>
</tr>
<tr>
<td>Dentist</td>
<td>52</td>
<td>96</td>
<td>28 (54)</td>
<td>24 (46)</td>
<td>30.12 (7.96)</td>
</tr>
<tr>
<td>Laypeople</td>
<td>58</td>
<td>94</td>
<td>21 (36)</td>
<td>37 (64)</td>
<td>31.00 (8.39)</td>
</tr>
</tbody>
</table>

* P = .074, analysis is based on chi-squared test.  
** P > .05 level, analysis is based on univariate analysis of variance.  
*** P = .063, analysis is based on Independent sample t-test.
photographic techniques to study prevalence, as well for the assessment of enamel color lesions. In addition, investigations of the perception of tooth color changes have usually asked raters to assess clinical photographs. Possible variables in oral conditions such as tooth morphology, spacing, and gingival characteristics may have influenced the perceptions of decalcification lesions. The present study used computer manipulated photographs of the smile by incrementally introducing decalcification lesions in varying severity, simulating the clinical appearance to eliminate such confounders.

Findings of the present study demonstrated that the three groups of raters could discriminate between various degrees of decalcification lesions. All raters gave a more negative score as the severity of the decalcification lesions increased (Table 2). The results of the present study were consistent with the findings of Maxfield et al., who reported a similar tendency of laypeople, orthodontists, and dentists to perceive the negative impact of decalcification lesions on the appearance of teeth. There are few investigations that compared the perception of tooth color changes due to fluorosis or enamel defects. Results of these studies showed a significantly less acceptance of fluorosis compared to normal tooth color, which was consistent with findings of the present study.

The results of the present study showed that general dentists were the most critical group of different decalcification levels (Table 2). Laypeople and dentists regarded decalcification levels 3, 5, and 8 to be significantly worse than orthodontists ($P < .05$), while dentists regarded decalcification levels of 4, 6, and 7 to be worse than orthodontists and laypeople ($P < .05$). The higher sensitivity of dentists to these lesions compared to orthodontists may have been due to the fact that orthodontists have become more familiar with seeing these lesions in their daily practice and have become desensitized. It is not surprising that laypeople were more critical of decalcification lesions than orthodontists. Perceptions of esthetics among laypeople have become increasingly more sensitive with increased exposure to multimedia that depict the

<table>
<thead>
<tr>
<th>Decalcification Score</th>
<th>Orthodontist</th>
<th>Dentist</th>
<th>Laypeople</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.3 (1.7)</td>
<td>23.2 (1.6)</td>
<td>21.8 (1.5)</td>
</tr>
<tr>
<td>2</td>
<td>23.9 (1.7)</td>
<td>21.8 (1.5)</td>
<td>20.9 (1.4)</td>
</tr>
<tr>
<td>3</td>
<td>21.4 (1.5)</td>
<td>16.6 (1.4)</td>
<td>16.5 (1.3)</td>
</tr>
<tr>
<td>4</td>
<td>17.7 (1.4)</td>
<td>11.4 (1.3)</td>
<td>16.8 (1.2)</td>
</tr>
<tr>
<td>5</td>
<td>19.0 (1.4)</td>
<td>12.0 (1.3)</td>
<td>14.4 (1.2)</td>
</tr>
<tr>
<td>6</td>
<td>17.3 (1.5)</td>
<td>11.2 (1.3)</td>
<td>13.9 (1.3)</td>
</tr>
<tr>
<td>7</td>
<td>12.5 (1.2)</td>
<td>5.3 (1.1)</td>
<td>9.1 (1.0)</td>
</tr>
<tr>
<td>8</td>
<td>13.9 (1.2)</td>
<td>6.5 (1.1)</td>
<td>7.7 (1.0)</td>
</tr>
<tr>
<td>Mean</td>
<td>18.7 (1.1)</td>
<td>13.5 (0.9)</td>
<td>15.1 (0.9)</td>
</tr>
</tbody>
</table>

* Statistically significant at 0.01 level, analysis is based on one-way ANOVA.
perfect smile as being one with straight and white teeth.

Orthodontists in this study were less critical than the general dentists when comparing the decalcification scores. When assessing the dentofacial region, orthodontists seem to focus on tooth position more critically than tooth color. This was evident in the findings of Kokich et al. (1999), where orthodontists ranked tooth position as most noticeable among four other dental features including tooth color.\(^9\)

It is important to acknowledge the importance of early detection of WSL by orthodontists. Enamel demineralization takes 4 weeks to develop, which is the typical review time for orthodontic patients treated with fixed appliances.\(^9\) WSL should be detected early enough to allow implementation of preventive measures to avoid any invasive procedures in the future.

CONCLUSIONS

- Orthodontists, general dentists, and laypeople could distinguish between various degrees of decalcification lesions.
- All raters gave more negative scores as the decalcification level increased.
- General dentists were the most sensitive group when rating decalcification lesions.

ACKNOWLEDGMENTS

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REFERENCES


