



# Lingual appliances reduce the incidence of white spot lesions during orthodontic multibracket treatment

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**Introduction:** The aim of this study was to assess the incidence of white spot lesions (WSLs) in subjects treated with customized lingual multibracket appliances—separately for maxillary anterior teeth 12 to 22 (according to the Fédération Dentaire Internationale numbering system) as well as for tooth groups 15 to 45, 16 to 46, and 17 to 47—and to determine the impact of patient-related and treatment-related variables on the frequencies of new WSLs. **Methods:** Of 214 subjects comprehensively treated between June 1, 2011, and May 31, 2014, in 1 orthodontic center (Bad Essen, Germany) with a completely customized lingual appliance (WIN; DW Lingual Systems, Bad Essen, Germany), 174 (47% boys, 53% girls; mean age,  $14.35 \pm 1.23$  years [minimum, 11.35 years; maximum, 17.91 years]) were recruited with inclusion criteria of completed lingual multibracket treatment of their maxillary and mandibular permanent teeth 17 to 47 (4582 teeth in the study), and age less than 18 years at the initial appointment. WSL assessment was accomplished using standardized digital high-resolution maxillary and mandibular occlusal photographs taken before bracketing and after debonding. Nonparametric analysis of variance was performed, taking into account the subjects' grouped ages ( $\leq 16$  or  $> 16$  years), sexes, and treatment durations. **Results:** Of the total population of subjects, 41.95% developed at least 1 new WSL when all teeth, 17 to 47, were considered, and this incidence was 27.01% for tooth group 16 to 46, or 10.59% of subjects and 4.74% of the maxillary incisors (12 to 22). Of all teeth under consideration, 3.19% developed a WSL during treatment. The frequencies of decalcification were not significantly increased in preadolescents ( $\leq 16$  years) compared with adolescents ( $> 16$  years). Treatment duration had a significant adverse impact on WSL formation in tooth groups 15 to 45 and 16 to 46, and in complete dental arches (teeth 17 to 47). **Conclusions:** Subject-related and tooth-related WSL incidences of both single tooth groups and complete dental arches in subjects treated with the lingual WIN appliance were distinctly reduced when compared with previous reports of enamel decalcification after conventional labial multibracket treatment. (*Am J Orthod Dentofacial Orthop* 2015;148:414-22)

**M**ultibracket (MB) treatment is a routine and frequent procedure used currently in orthodontics because it is the only noncompliance

treatment approach for 3-dimensional dental arch adjustments. However, its downside is the increase in the risks of white spot lesion (WSL) formation and incipient caries.<sup>1</sup> Despite the general tendency of WSL surfaces to remineralize and harden after debonding, the esthetic aspect in maxillary anterior teeth affected by WSLs and decalcifications remains highly problematic,<sup>2-4</sup> even 12 years after treatment.<sup>5</sup> Therefore, prevention and treatment of WSLs have become matters of concern among orthodontists, and a health care market has emerged in recent decades to respond to this situation, including new microinvasive approaches for WSL infiltration and camouflage.<sup>6</sup> Nonetheless, it is undeniable that even thorough oral hygiene is not sufficient for preventing WSLs in many patients.<sup>1,7</sup> Moreover, further preventive strategies, such as the application of fluoride-releasing sealants and bonding materials, daily rinsing with sodium fluoride mouth rinse, or

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The first author invented the WIN system, which is manufactured by DW Lingual Systems, Bad Essen, Germany; he is the CEO of the company.

The other authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.

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**Table 1.** Definition of specific tooth groups with the Fédération Dentaire Internationale (FDI) numbering system used in the text and the universal numbering system (UNS)

Tooth group	Maximum number of teeth per subject	Definition by FDI numbering system (universal numbering system)
12-22	4	Maxillary incisors: 22, 21, 11, 12 (UNS: teeth 7, 8, 9, 10)
15-45	20	Maxillary and mandibular incisors, canines, first and second premolars: 11-15, 21-25, 31-35, 41-45 (UNS: teeth 4-13 and 20-29)
16-46	24	Maxillary and mandibular incisors, canines, first and second premolars, and first molars: 11-16, 21-26, 31-36, 41-46 (UNS: teeth 3-14 and 19-30)
17-47	28	Maxillary and mandibular incisors, canines, first and second premolars, and first and second molars: 11-17, 21-27, 31-37, 41-47 (UNS: teeth 2-15 and 18-31)

chlorhexidine applications, have failed to prevent WSL formation.<sup>8-11</sup> An additional source of frustration is the finding from previous research of increased WSL susceptibility in preadolescents, who are also a major age group for MB interventions.<sup>12,13</sup>

Intensive clinical studies of WSL formation on maxillary incisors and canines as a side effect of buccal MB treatment have found subject-related incidences of at least 1 new WSL of 46% within 12 months,<sup>14</sup> or 36% for maxillary and mandibular incisors,<sup>12</sup> whereas other authors have even reported 60.9% for maxillary incisors considered alone.<sup>2</sup> For all maxillary and mandibular anterior and posterior teeth, including the first molars, 16 to 46 (according to the Fédération Dentaire Internationale numbering system), WSL incidences up to 72.9% can be expected during MB interventions.<sup>3</sup>

As a totally different approach to preventing WSL formation during orthodontic treatment, the use of lingual MB appliances has recently been reconsidered as a method that is potentially superior to conventional labial fixed orthodontic treatment because of the reduced occurrence of decalcifications on lingual enamel surfaces.<sup>15</sup> However, detailed information derived from clinical studies is limited. Although there are many studies or systematic reviews available regarding the incidence of WSL formation during labial bracket treatment as a function of location, subject age and sex, and even as an iatrogenic side effect of surplus orthodontic etching, there is not enough equivalent information concerning lingual-bracket induced WSLs that would enable us to support or reject the hypothesis of improving WSL prevention during comprehensive orthodontic treatment simply by choosing lingual appliances instead of conventional fixed labial approaches.<sup>2,3,14,16-18</sup>

A potential disadvantage of lingual orthodontic treatment is that additional costs compared with conventional MB treatment may be incurred initially. However, if the hypothesis of a decreased incidence of WSLs is valid, these costs may be balanced against the costs of preventive measures against WSLs, such as the use of

enamel sealants, as needed when using conventional MB appliances, or potential costs that may be incurred for treatment of labial WSLs, such as microabrasion or resin infiltration.<sup>6</sup>

The objective of this study was to assess the incidence of WSL formation in subjects treated with completely customized lingual MB appliances (WIN; DW Lingual Systems, Bad Essen, Germany), separately for the maxillary incisors (12-22; Table 1), as well as for tooth groups 15 to 45, 16 to 46, and 17 to 47, to allow comparisons with existing data on labial WSL formation and consider the impact of patient variables (age,  $\leq 16$  or  $> 16$  years; and sex) and treatment duration on WSL formation.

## MATERIAL AND METHODS

Our report is based on a single-center retrospective study of the incidence of WSL induced by lingual MB appliances.

Of 214 patients comprehensively treated from June 1, 2011, to May 31, 2014, in 1 orthodontic center (Bad Essen, Germany) with completely customized lingual WIN appliances, 174 participants (82 boys [47%], 92 girls [53%]; mean age,  $14.36 \pm 1.23$  years [minimum, 11.35 years; maximum, 17.91 years]) were recruited. We adopted the following inclusion criteria: (1) lingual MB treatment of the maxillary and mandibular permanent teeth (from central incisor to second molar) with the WIN appliance; (2) age less than 18 years at the initial appointment; (3) debonding completed; and (4) high-quality initial and final intraoral top-view photographs. The exclusion criterion was missing or low-quality photographs.

Accordingly, of the 214 potentially eligible subjects, 40 (18.69%) were excluded from analysis because they were 18 years of age or older. None was excluded because of missing or low-quality photographs.

Single deciduous teeth and teeth with restorations in the area of the palatal or lingual bracket bases were excluded from the analysis, as were teeth whose lingual surfaces were not clearly visible or could not be judged

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