Minimally invasive resin infiltration of arrested white-spot lesions

A randomized clinical trial

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ABSTRACT

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Background. The authors conducted a randomized, single-masked clinical trial involving patients who had completed orthodontic treatment to assess changes in the appearance of white-spot lesions (WSLs) that were treated with resin infiltration.

Methods. The authors divided affected teeth into control and treatment groups. In the treatment group, they restored teeth with WSLs by using resin infiltration. They evaluated changes in WSLs photographically by using a visual analog scale (VAS) (0 = no change, 100 = complete disappearance) and area measurements (in square millimeters). The authors analyzed the data by using two-way analysis of variance.

Results. The mean VAS ratings for treated teeth demonstrated marked improvement relative to that for control teeth immediately after treatment (67.7 versus 5.2, $P < .001$) and eight weeks later (65.9 versus 9.2, $P < .001$). The results for treated teeth showed a mean reduction in WSL area of 61.8 percent immediately after treatment and 60.9 percent eight weeks later, compared with a –3.3 percent change for control teeth immediately after treatment and a 1.0 percent reduction eight weeks later.

Conclusions. Resin infiltration significantly improved the clinical appearance of WSLs, with stable results seen eight weeks after treatment.

Practical Implications. Resin infiltration, a minimally invasive restorative treatment, was shown to be effective for WSLs that formed during orthodontic treatment.

Key Words. Resin infiltration; white-spot lesions; demineralization.

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Enamel white-spot lesions (WSLs), an outcome of enamel demineralization, are common sequelae of poor oral hygiene. With orthodontic treatment, the presence of fixed appliances makes oral hygiene more difficult, increasing susceptibility to WSL formation.[1,2] The reported prevalence of WSLs in orthodontic patients ranges from 4.9 percent[3] to 97 percent,[4] with investigators in a 2011 study reporting that 72.9 percent of patients developed a WSL during treatment.[5] WSLs associated with subsurface enamel porosities are caused by a cyclical imbalance between demineralization and remineralization, resulting from an acidic environment created by cariogenic bacteria.[6] With time, remineralization at the outer surface of the lesion decreases access of calcium and other ions to deeper portions of the lesion, resulting in an arrest of the remineralization process,[2,7,8] which often is referred to as arrested WSLs.

The lesion's opaque white appearance is due to scattering of light at

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the subsurface demineralized enamel.[6,9] WSLs may regress naturally owing to salivary remineralization and toothbrush abrasion; however, complete regression does not occur for most lesions.[10,11] Regression of WSLs after removal of orthodontic appliances occurs predominantly in the first three months, and lesions present after this time are likely to remain.[12]

Topical remineralization therapy is one treatment approach for WSLs. However, improvements from remineralization therapy that involve the use of casein phosphopeptide amorphous calcium phosphate,[13] low-concentration fluoride[14] or a combination of the two[15] have been found to be minimal and often clinically insignificant.[16,17] Bleaching also results in limited esthetic improvement and has been associated with tooth sensitivity and a reduction in enamel microhardness.[18-20] In general, complete remineralization of WSLs does not occur with topical applications of various products.[21]

Other treatment options for WSLs include microabrasion and restoration. Although microabrasion can remove WSLs, the technique has the potential to remove large amounts of enamel.[16,22] Tooth preparations for traditional resin-based composite restorations, veneers and crowns require removal of enamel beyond the demineralized zone and may extend into dentin.[23] Because orthodontic WSLs predominantly affect a young patient population, long-term prognosis of the restored teeth is a significant concern. Considering the invasiveness of microabrasion or traditional restorations compared with the relatively small amount of demineralized enamel in WSLs, a less invasive restorative technique would be preferable.

Resin infiltration has been marketed as a minimally invasive restorative treatment option and involves penetration of a resin into the body of the WSL, with minimal loss of enamel.[24] With this method, the clinician uses an acid etchant to remove the outer layer of sound remineralized enamel, exposing the demineralized lesion body; he or she subsequently fills the lesion with a low-viscosity resin.[24] The results of in vitro studies have shown significant masking of WSLs with use of resin infiltration techniques.[25-27] Initial in vivo case report findings have been promising, showing immediate significant improvement in the appearance of WSLs.[28,29] Although clinicians have used resin infiltration for restoration of teeth with interproximal incipient caries, no randomized clinical trials, to our knowledge, have been conducted to evaluate resin infiltration of WSLs.

The purpose of this randomized, single-masked clinical trial was to assess the esthetic improvement and changes in the area of WSLs treated with resin infiltration. Patients who had developed WSLs during orthodontic therapy were treated with a commercially available resin infiltration system. We obtained photographs of WSLs before treatment (T1), immediately after treatment (T2) and eight weeks later (T3). Using the photographs, orthodontists rated changes in the appearance of the WSLs and measured changes in the WSL area. Our hypothesis was that WSLs in teeth restored with resin infiltration would have an improved appearance and a reduced area compared with untreated WSLs.

METHODS

The institutional review board at the Oregon Health & Science University, Portland, approved this study. Power analysis, assuming an estimated 70 percent improvement in appearance on the basis of changes in WSLs treated with resin infiltration reported in a previous study,[29] indicated that a minimum sample size of 20 patients was needed to show significance at a power of 80 percent. Allowing for a 30 percent dropout rate, we set an enrollment goal of 30 participants. We allocated patients according to Consolidated Standards of Reporting Trials (CONSORT) guidelines (Figure 1).[30]

To recruit participants from the orthodontic clinic of the Oregon Health & Science University, the lead investigator (S.V.S.) searched patient records consecutively and retrospectively from December 2011 to December 2007. Initial screening for inclusion was based on intraoral photographs obtained immediately after removal of orthodontic appliances that showed WSLs on at least two maxillary anterior teeth. Additional inclusion criteria included an absence of preexisting (before orthodontic treatment) white spots determined on the basis of pretreatment photographs, patient age in the range from 12 through 30 years, no previous treatment of WSLs, at least three months having elapsed since removal of orthodontic appliances, WSLs having an International Caries Detection and Assessment System (ICDAS)[31] score of 2 (that is, distinct visual change in enamel opacity) or 3 (localized enamel breakdown due to caries with no visible

ABBREVIATION KEY. CONSORT: Consolidated Standards of Reporting Trials. **ICDAS:** International Caries Detection and Assessment System. **NA:** Not applicable. **VAS:** Visual analog scale. **WSL:** White-spot lesion.