Caries risk after interproximal enamel reduction

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Introduction: Air-rotor stripping (ARS) is a commonly used method to alleviate crowding in the permanent dentition. Its widespread acceptance, however, has been limited by the potential increase in caries risk of the abraded enamel surface. The aim of this study was to compare the susceptibility of ARS-treated enamel surfaces with intact surfaces in patients undergoing fixed orthodontic therapy. **Methods:** Forty patients treated with ARS were examined clinically and radiographically for caries 1 to 6 years after interproximal enamel reduction. All patients were seen by their dentists for prophylaxis at 6-month intervals during active orthodontic treatment and were exposed to fluoridated water and toothpaste. Topical fluoride agents or sealants were not applied on the abraded surface after any ARS session. Caries incidence was compared between ARS-treated and unaltered surfaces within subjects. The decayed, missing, filled tooth (DMFT) and surface (DMFS) scores were used to evaluate the subjects' overall caries risk. **Results:** Totals of 376 test and 376 control surfaces were examined. The number of interproximal lesions detected was found to be low with no statistically significant difference detected between the groups (test = 3; control = 6; P = .33]. The DMFT and DMFS scores increased significantly during the study period, indicating that these patients were clearly at risk of tooth decay (P <.001). **Conclusions:** The findings indicate that the risk of caries is not affected by ARS. Furthermore, our data show that the application of topical fluoride on the enamel surfaces immediately after ARS in patients exposed to fluoridated water and fluoride-containing toothpaste may not provide any additional benefit. (Am J Orthod Dentofacial Orthop 2006;130:26-30)

Air-rotor stripping (ARS) consists of the removal of interproximal enamel to correct crowding.[1] Studies have shown that 7 mm of space can be predictably created with a 50% reduction of the enamel thickness of the premolars and the first molars, with an additional gain of 2.5 mm if the anterior dentition is also included.[2,3] In selected patients with moderate to severe crowding, ARS has the advantage over extraction therapy of a significant reduction in treatment time since the amount of tooth structure removed corresponds exactly to the amount of crowding. Further, the preserved intercanine width and broadened contact surfaces can help prevent posttreatment relapse. Potential adverse effects such as periodontal problems associated with root proximity[4] and development of interarch tooth-mass discrepancy[2] when stripping is limited to 1 arch have been found to be of little clinical significance. However, the potential increase in caries susceptibility of the abraded enamel surfaces is a source of concern.

Dental caries is an infectious disease resulting in the destruction of mineralized tooth tissues. The initiation of the disease process depends on the presence of cariogenic bacteria, fermentable sugars, and a susceptible tooth, as originally proposed by Keyes.[5] When exposed to fermentable sugars, cariogenic organisms such as *Streptoccoccus mutans* and *Lactobacillus* species produce lactic acid, causing a drop in the local pH which, in turn, increases the risk of enamel demineralization and, ultimately, caries formation.[6] Still, although Keyes' triad is essential for the development of tooth decay, the expression of the disease is influenced by several additional risk conditions. The frequency of sugar consumption,[7] the chemical and physical properties of saliva,[8] the tooth's intrinsic resistance,[9] and access to preventive dental care might affect the rate of caries initiation and the progression of the disease. Fixed orthodontic appliances increase the number of plaque-retentive sites and, as a result, increase the risk of enamel surface demineralization compared with untreated subjects.[10,11] However, a higher incidence of cavitated lesions in patients undergoing fixed orthodontic therapy has never been demonstrated clinically.[12]

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Since the introduction of the ARS technique, concerns have been raised about the potential increase in caries susceptibility of the abraded enamel surface.[13,14] Studies have shown that ARS leaves deep grooves and furrows on the enamel surface, regardless of the polishing method, creating plaque-retentive areas.[13] In addition, abraded enamel surfaces have been reported to be more prone to demineralization than intact surfaces under in-vitro conditions.[14] The latter has been attributed, in part, to the removal of the external, less soluble, fluoroapatite-rich enamel layer.[9] Consequently, the application of topical fluoride products after enamel reduction has been advocated. Furthermore, a proximal sealant or chemical enamel etching can be used to recreate a smooth enamel surface.[15-17] Although a potential risk clearly exists, differences in caries incidence between ARS-treated and control surfaces have never been observed clinically.[18] The lack of controlled studies and limited data currently available make it impossible to rule out a potential association. The purpose of this study was to determine whether enamel surfaces subjected to mechanical reduction are more susceptible to caries formation than unaltered control surfaces in patients undergoing fixed orthodontic therapy.

MATERIAL AND METHODS

Forty patients treated with ARS to relieve crowding, completing treatment between 1997 and 2001, were enrolled in this study. All were treated in the graduate orthodontic clinic at Montefiore Medical Center, Bronx, NY, and were examined a minimum of 12 months (range, 12-78 months) after interproximal enamel reduction. The study was approved by the ethics committee, and all subjects signed an informed consent at recruitment.

Demographic characteristics were obtained by patient interviews and questionnaires. The patients were predominantly Hispanic or black, of low socioeconomic status, with an almost equal distribution of male and female subjects (Table I). Pertinent information about the orthodontic treatment was obtained by reviewing each patient's chart and records. The total amount of stripping performed on each patient was estimated by multiplying the number of ARS-treated surfaces by 0.5 mm (estimated amount of enamel removed from each surface). Enamel reduction was performed with a fine tapered diamond bur (465514 016, Brasseler USA, Savannah, Ga), and the surface was subsequently polished with a diamond-coated strip (Single Sided Strip 97-480-04, GAC International, Bohemia, NY). The procedure was not followed by the application of any sealant or fluoride-based products nor was the use of any fluoride product other than toothpaste recommended during treatment.

Table I. Demographic characteristics of study population (n = 40)

Age (y)	Mean, 19.5 (range, 13-40)
Male (%)	52.6
Female (%)	47.4
Hispanic (%)	76.4
Black (%)	15.8
White (%)	5.2
Indian (%)	2.6

Prior to the initiation of orthodontic treatment, all subjects had a routine caries screening by their dentists and were considered caries-free at baseline. During treatment, the patients were instructed to see their dentists at regular 6-month intervals for routine care. All patients lived in communities with fluoridated water (fluoride concentration, 1 ppm).

All patients were subjected to full-mouth clinical and radiographic caries assessments. All examinations were performed by a calibrated examiner (G.G.), blinded as to which teeth and surfaces had received interproximal reduction. Clinically, caries detection was performed with a fine tip explorer with the operative light as the sole source of illumination. A surface was considered carious if it was soft upon tactile exploration and if the instrument bound to the cavitated area. Caries on each surface was recorded as present or absent, regardless of extent. Interproximal caries was compared between ARS-treated and contralateral intact surfaces. If the contralateral tooth was missing or the surface had also been stripped, the diametrically opposed tooth and corresponding surface were used as controls. In addition to carious lesions, missing teeth and restored surfaces of all teeth were recorded, and the decayed, missing, and filled tooth (DMFT) and the decayed, missing, and filled surface (DMFS) indexes calculated. Baseline indexes were generated from the pretreatment radiographs.

Posterior bitewing and anterior periapical radiographs were taken by using the standardized long cone technique and a Rinn XCP film-holding device (Dentsply, York, Pa).[19] In all instances, Kodak Ultra Speed D films (Eastman Kodak, Rochester, NY) were exposed at 70 KvP, 10 mA, and 15 impulses. All radiographs were examined under 2.5 x magnifying loupes. Radiographically, caries was considered present if an ill-defined decrease in density could be detected, regardless of the depth of penetration. All radiographs were examined twice, 4 weeks apart. Du-

Table II. Clinical characteristics of study population

ARS-treated surfaces (n)	376
ARS-treated teeth (n)	214
Mean ARS-treated teeth per patient	5.35
Mean enamel reduction per patient (mm)*	4.7

*Average reduction of 0.5 mm per surface.

Table III. Caries distribution in ARS-treated and control surfaces

	Caries present	*Caries absent*
ARS-treated	3	373
Control	6	370

plicate readings resulted in 100% agreement in lesion detection.

Statistical analyses were performed with SAS software (Cary, NC). The chi-square test was used to compare the caries distribution between ARS-treated and control surfaces. The Student *t* test was used to compare changes in the DMFS and DMFT indexes during the study period. A *P* value of .05 was used as the level of statistical significance.

RESULTS

As shown in Table II, 376 ARS-treated surfaces on 214 teeth were included in this study. An equal number of surfaces were used as controls. On average, 9.4 surfaces were subjected to stripping for each patient, for a mean estimated reduction of 4.7 mm per subject. In all patients, the space gained was sufficient to completely correct the crowding.

As shown in Table III, the incidence of interproximal carious lesions during the observation period was low. A total of 9 new interproximal lesions were found either clinically or radiographically, with 6 on control surfaces and only 3 on surfaces subjected to stripping. The difference was not statistically significant (P = .33). Interproximal caries were found in 9 patients (23%); no patient had more than 1 carious surface. None of the ARS or control surfaces was found to have been restored during the observation period.

Table IV indicates that the DMFT and DMFS index scores significantly increased during the study period. The mean increases in scores were similar, indicating that not more than 1 surface per tooth was affected for most patients. The observed changes were mostly attributed to increases in occlusal caries.

DISCUSSION

Because there is controversy about the potential role of ARS in the development of interproximal

Table IV. Comparison of DMFT and DMFS indexes between baseline and recall examinations

	Baseline mean (SD)	*Recall mean (SD)*	*Difference recall-baseline (SD)*	P *value*
DMFT	2.98 (3.80)	4.48 (4.37)	1.5 (1.8)	<.001
DMFS	4.75 (8.75)	6.55 (9.23)	1.8 (2.2)	<.001

carious lesions, this study was undertaken to determine whether surfaces subjected to enamel stripping to relieve crowding were at greater risk of caries than nonabraded control surfaces. Our data indicate that, although the incidence of new carious lesions on ARS-treated and control surfaces was low, no statistically significant difference was found between the groups. These findings corroborate the results of previous studies.[18,20,21] El-Mangoury et al[20] compared the enamel surface morphology of premolars subjected to interproximal stripping with contralateral intact premolars after 6 and 9 months and found no difference in the incidence of caries between the teeth. Crain and Sheridan[18] examined clinically and radiographically ARS-treated and untreated tooth surfaces 2 to 5 years after enamel reduction and reported no significant difference in the percentages of new caries between the stripped and intact surfaces. Radlanski et al[21] reported similar findings a year after stripping the mandibular central incisors. Although it can be argued that the caries risk for mandibular incisors is low in general, their observations are of interest because furrows created at enamel reduction were still clearly visible 1 year later. However, in spite of the plaque-retentive depressions, no caries were found.

The changes in enamel morphology after mechanical stripping have been thoroughly documented.[13,15,22,23] Studies comparing polishing methods after ARS show that, regardless of the technique used, furrows varying in depth between 15 and 30 μm remained on the enamel surface.[13,15,22,23] These furrows were shown to facilitate plaque accumulation, which is then shielded from the mechanical action of the floss.[13] However, the results from this study and others indicate that, even if abraded enamel appears to establish an environment favorable for caries development, it does not necessarily translate into a clinically significant event.[18,21] This finding has additional significance because our subjects were clearly at risk of caries, as evidenced by the significant increase in DMFT and DMFS scores during the study period. It remains possible that the amount of mineral loss was greater on the ARS-treated surfaces but without leading to cavitation.

Some authors have recommended the application of fluoride products immediately after stripping to prevent further mineral loss and promote remineralization.[14,15] Twesme et al[14] found that abraded enamel surfaces were more susceptible to enamel demineralization than intact surfaces in-vitro. A reduction in the extent of mineral loss on the abraded surface was observed after fluoride exposure, although the amount of demineralization was greater than on intact surfaces. O'Reilly and Featherstone[24] found that daily rinsing with sodium fluoride (0.05%) or weekly applications of acidulated phosphate fluoride gel, both used with fluoride-based toothpaste, could prevent demineralization or promote remineralization when administered over a 4-week period. Clinically, a reduction in the incidence of white spot lesions was reported in orthodontic patients treated with fixed bonded appliances who followed a controlled fluoride program.[25]

Still, it is questionable whether fluoride treatment to prevent interproximal caries after ARS results in any clinically significant benefits in patients already exposed to fluoridated water and toothpaste. Joseph et al[15] found that teeth exposed to low concentrations of calcium solution for 5 to 10 hours after chemical enamel etching had marked crystal growth in-vitro. Brudevold et al[26] found that remineralization of abraded enamel surfaces occurs as early as 1 hour after exposure to the oral environment. These observations were corroborated clinically by El-Mangoury et al,[20] who reported evidence of remineralization by scanning electron microscopy of enamel surfaces subjected to stripping 9 months earlier without concomitant fluoride treatment. Fluoride levels of 500 to 1000 ppm at neutral pH, such as those in commercially available toothpastes, have been shown to react with enamel apatite crystals to form calcium fluoride, which upon dissolution provides sufficient fluoride in solution to suppress significant enamel demineralization.[27] Thus, fluoride is incorporated in newly formed crystals, resulting in a structure similar to fluoroapatite and more resistant to subsequent acid attacks.[28] Assessment of the patient's caries risk and level of fluoride exposure are necessary to determine the need for fluoride supplementation after ARS.

No additional oral hygiene instructions or aids were provided to the patients other than those routinely given immediately after appliance placement. Considering the impact of poor plaque control on caries development, one could attribute the absence of any significant difference in caries incidence observed between the groups to the lack of control of this variable. However, our study found that caries were not evenly distributed between test and control surfaces within patients. Further, no more than 1 interproximal carious lesion was found in any patient. Consequently, the lack of any extensive plaque control measures in this study appears to have had a minimal impact on the observed results.

CONCLUSIONS

Our findings indicate that ARS stripping does not result in an increase in enamel caries in patients undergoing orthodontic therapy with fixed bonded appliances. In addition, topical fluoride application of the abraded enamel surface seems to have limited beneficial value in preventing caries formation in patients exposed to other sources of fluoride, such as fluoridated water and toothpaste. However, controlled studies are required to evaluate the relative value of fluoride supplementation for caries prevention after ARS in patients not exposed to fluoridated water.

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