Original Article

Comparison between phosphoric acid and hydrochloric acid in microabrasion technique for the treatment of dental fluorosis

Mahshid Mohammadi Bassir, Golnaz Bagheri[1]

Department of Operative Dentistry, [1]General Dentist, Faculty of Dentistry, Shahed University, Tehran, Iran

Abstract

Purpose: To compare the effectiveness of phosphoric acid (H_3PO_4)-pumice compound with conventional hydrochloric acid (HCl)-pumice compound in treating different severities of dental fluorosis with the microabrasion technique.

Materials and Methods: Sixty-seven anterior teeth from seven patients with different severities of dental fluorosis were treated. In each patient, half of the teeth were treated with HCl-pumice compound and the other half with H_3PO_4-pumice compound (split-mouth design). Both treatment compounds were applied for 30-second periods and treatment continued up to 10 minutes. Before and after treatment, standardized photographs were taken. The photographs were compared by two experienced observers unaware of the modality of treatment. Two indices of aesthetics, improvement in appearance (IA) and degree of stain removal (DSR), were determined according to a visual analog scale. The inter- and intra-correlation coefficients were made; then, statistical analyses were calculated using Mann-Whitney and *t*-test.

Results: There were no significant differences in interobserver evaluation. Improvements in aesthetic indices were observed in all fluorotic teeth by both compounds; however, the mean treatment time with HCl-pumice was significantly lower than H_3PO_4-pumice.

Conclusion: The H_3PO_4-pumice compound improved aesthetic indices in fluorotic teeth similar to the HCl-pumice compound.

Keywords: Fluorosis, microabrasion, hydrochloric acid, phosphoric acid

INTRODUCTION

Fluorosis is one of the most common types of enamel dysmineralizations.[1] Initially, it involves subsurface hypomineralization and/or porosity of the enamel but may extend through the whole thickness as the severity increases.[2] The discoloration may range from yellow to dark brown.[3] Enamel discoloration especially in the anterior teeth may raise esthetic concerns in patients. Conservative non-restorative methods such as microabrasion technique has been employed in the treatment of dysmineralization defects and discolorations.[4] This technique which involves mild acid etching in combination with rotary application of an abrasive medium,[5] was first described by Dr. Walter Kane (Colorado Springs, 1916). By rubbing six maxillary anterior teeth with hydrochloric acid (HCl) under the flame of an alcohol torch, he found favorable results in the treatment of enamel fluorosis without any destruction or damage of enamel. However, for more than 60 years, most clinicians avoided applying this technique, because of fear of damage or destruction of the enamel.[6,7] In 1984, McCloskey introduced the use of acid combined with pumice [7] which was named 'microabrasion' by Croll two years later.[8] Considering its high incidence, the dentist should be able to diagnose fluorosis properly and treat it well. Phosphoric acid (H_3PO_4) that is commonly used for etching in dental clinics is a well-known acid for the dentist. Bezzar *et al*. (2005) compared the efficacy of microabrasion obtained by two types of acid: 37% H_3PO_4 and 18% HCl. They applied H_3PO_4 on teeth numbers 11 and 12 of each patient and HCl on teeth numbers 21 and 22 incisors. They showed that both acids were equally effective.[2] Meireles *et al*. (2009) reported lower mean surface roughness and larger total demineralization area in teeth treated with HCL-pumice in comparison with the H_3PO_4-pumice compound.[9]

This study was conducted to compare the clinical efficacy of the two microabrasion compounds (HCL-pumice and H_3PO_4-pumice) in a split-mouth study design. In addition,

Address for correspondence:
Prof. Mahshid Mohammadi Bassir, Department of Operative Dentistry, Faculty of Dentistry, No 91, Italia St, Vessal Ave, Tehran, Iran. E-mail: mohammadibassir@shahed.ac.ir

Date of submission : 26.04.2012
Review completed : 05.05.2012
Date of acceptance : 04.06.2012

Access this article online	
Quick Response Code:	Website: www.jcd.org.in
	DOI: *****

pure microabrasion period for application of the two compounds in each side of the mouth was measured.

MATERIALS AND METHODS

Subjects with fluorosis were solicited by two experienced clinicians (MRR, MBR) among the patients who referred to The dental school. Subjects with extremely poor oral hygiene or periodontal disease and caries on anterior teeth were excluded. The clinicians carried out the evaluation using a mouth mirror, an explorer, and periodontal probe. At first, the teeth were cleaned with prophylactic paste to enable assessing them accurately. Then they were dried with cotton rolls, and within 30 seconds of drying, the degree of staining was determined. The investigators classified the patients into mild, moderate, or severe groups according to Dean's index for dental fluorosis. Dean's index was modified slightly for use in this study by combining the categories of mild and very mild.

Before the clinical assessment, the observers were asked to classify photographs of fluorotic teeth from a previous study. Any disagreement with the previous classification was reviewed and discussed until consistency was achieved.

Seven adults with diffuse opacities on enamel surfaces of incisors suggestive of dental fluorosis were selected [Figure 1], and written informed consents were obtained prior to beginning of the study.

Color photographs of the teeth were taken by the same ring flash and camera. All photographs were taken at a pre-established, standardized setting and focal length in the same dental unit.

Microabrasion treatment was carried out by one other calibrated operator (GB). For calibration procedure (step), the operator clinician (GB) treated two patients under the supervision of the experienced clinician (MMB). After that, the operator was considered qualified for initiating the microabrasion procedures. These patients were not enrolled in the study. Before treatment, eight anterior teeth were isolated with a rubber dam (Optra Dam, Ivoclar Vivadent). The method of application followed the split-mouth study design. For each patient, two compounds were randomly selected and designated 'left' or 'right'. Both microabrasion materials were used on each patient. A coin was tossed to determine the compound being applied to each side. A thick layer of microabrasion compound was applied over the discolored area of the facial surface of the affected teeth with a contra-angle handpiece in low speed. 'Treatment' was defined as a 30-second application of the microabrasion paste. Following each application (30 seconds), the compound was removed with wet gauze and the teeth were rinsed before the experienced observer (MMB) evaluated for the remaining stains of fluorosis.

As instructed by Croll,[6,8] evaluation of the teeth were performed when they were wet. Continuing or discontinuing of treatment was based upon whether staining still remained. Periodically, the teeth were evaluated visually for thickness of the labial enamel. Every patient received the entire microabrasion treatment in a single appointment. At the end of the treatment, neutral sodium fluoride gel (1.2%) was applied for four minutes. The rubbing time of the microabrasion compound was measured in each group. All severities of fluorosis stain, as measured by Dean's index, were treated in this study. To avoid the influence of dehydration caused by isolation of the rubber dam, postoperative photographs were taken after one hour with the same condition as mentioned above [Figure 2]. Therefore, 67 teeth from seven patients were treated, 34 teeth with HCl-pumice compound and 33 teeth with H_3PO_4-pumice compound. At the end of

Figure 1: Photograph of a patient with moderate fluorosis before treatment

Figure 2: Photograph of the same patient after treatment (right side microabraded with HCl-pumice and left side with H_3PO_4-pumice)

the treatment, the patients were asked the following questions to assess their aesthetic improvement:

Are you a) very satisfied? b) satisfied? c) unsatisfied?

Representative photographs from each patient were randomized and viewed independently by two other experienced clinicians (MBR, MRR) who were unaware of the kind of treatment. For training purposes, photographs of the teeth subjected to microabrasion technique and the representative of each score were observed. Then, both clinicians reviewed approximately 10 patients subjected to the microabrasion procedure at baseline and after treatment on two occasions (they were not included in the sample). A score was given for each case. An initial intra and interobserver agreement of at least 85% was considered necessary before evaluation of the photographs. Both sides of the mouth were evaluated using a visual scale ranging as described by Price *et al*.[10] Two indices of aesthetics consisting of improvement in appearance (IA) and degree of stain removal (DSR) were determined according to a visual analog scale from 1 (no improvement in appearance or stain not removed at all) to 7 (exceptional improvement in appearance or stain totally removed). The mean rank for IA and DSR in the two techniques were measured and Mann-Whitney test used for analysis. The mean of treatment time (period) in each experimental group was measured and *t*-test was used for comparison.

RESULTS

Both observers identified a difference (improvement) between pre and post-treatment photographs in all patients. The interclass correlation coefficient (ICC) between the two observers for IA and DSR were 0.772 and 0.837, respectively. The mean rank for IA in HCl-pumice and H_3PO_4-pumice groups were 6.58 ± 0.70 and 6.39 ± 0.75 [Table 1] and the mean rank for DSR in the HCl-pumice and H_3PO_4-pumice groups were 6.53 ± 0.79 and 6.36 ± 0.78 [Table 2], respectively. The t-test showed no significant difference between the two groups in this respect. The mean treatment time in the HCl-pumice group (53.03 seconds) was significantly lower than the H_3PO_4-pumice group (76.39 seconds). The *t*-test showed a statistically significant difference between these two groups ($P = 0.001$) All the patients reported being very satisfied at the end of the treatment.

Table 1: Comparison of improvement in appearance (IA) between two groups

Group	No improvement	Exceptional improvement	Mean	SD	*P* value
HCl-pumice	5	7	6.58	0.70	0.12
H_3PO_4-pumice	5	7	6.39	0.75	

HCl: Hydrochloric acid, H_3PO_4: Phosphoric acid

Table 2: Comparison of degree of stain removal (DSR) between two groups

Group	No improvement	Exceptional improvement	Mean	SD	*P* value
HCl-pumice	4	7	6.53	0.79	0.28
H_3PO_4-pumice	4	7	6.36	0.78	

HCl: Hydrochloric acid, H_3PO_4: Phosphoric acid

DISCUSSION

Any impairment in the formation of the inorganic part of enamel may cause enamel dysmineralization. These defects of the enamel surface can exhibit white opacities, brown, yellow, or orange opacious spots and streaks, or multicolored superficial defects.[11-13]

The affected enamel has normal thickness but increased white opacities with no clear borders with the adjacent normal enamel.[3] As other conditions may result in similar patterns of enamel damage, a definite diagnosis of fluorosis can be made when the defects present in a bilaterally symmetric distribution and evidence of prior excessive fluoride intake is established.[3] In view of these facts, patient selection and photographic evaluation were performed by two experienced clinicians (MBR, MRR). For standardization of the treatment method, all patients were treated by one clinician (GB).

Excessive fluoride may cause enamel hypomineralization via alterations on the rates of matrix protein breakdown and/or rate of removal of byproducts from maturing enamel. Fluoride does not seem to affect the production and secretion of enamel matrix protein and proteases within the dose range causing dental fluorosis in humans. Most likely, fluoride uptake interferes indirectly with the protease activity by decreasing free Ca^{2}+ concentration in the mineralizing milieu. Any interference with enamel matrix enamel removal could lead to effects on the accompanying crystal growth through the maturation stages resulting in different magnitudes of porosity of the enamel at the time of tooth eruption.[14]

The two microabrasion compounds would be able to remove the stains from enamel and improve the appearance of the teeth in a similar manner. Similar results were reported in a 15-subject clinical trial by Bezarra and colleagues, who showed that both acids (37% H_3PO_4 18% HCl with pumice) can be used successfully without any statistically significant clinical differences.[2] Removal of superficial discolorations of enamel is commonly based on mild acid etching in combination with rotary application of an abrasive medium.[15] Microabrasion not only removes the stained surface layer of the enamel but also creates a highly polished and compact surface layer.[10,16]

Although the exact reason for the color change that occurs after microabrasion is not known, the microabraded

surface reflects and refracts light from the surface in such a way that mild imperfections in the underlying enamel are camouflaged. The highly polished surface of the enamel following abrasion with HCl-pumice enhances the aesthetic appearance.[10,17]

Mild surface abrasion of the enamel prisms with simultaneous acid erosion compacts the mineralized tissue within the organic region of the enamel, replacing the outer prism-free region. Light reflected off and refracted through this new surface is thought to act differently than light from an untreated enamel surface.[10,17,18] In addition, subsurface stains may be camouflaged by the optical properties of the newly microabraded surface.[17] Croll has named this phenomenon 'the abrasion effect'.[16] Comparison of mean treatment time period between the two groups showed a significant statistical difference ($P < 0.05$). In other words, microabrasion with H_3PO_4-pumice compound takes more time, although this time period (23.365 seconds) does not seem to be significant in clinical practice.

Miereles *et al*. showed that enamel treated with H_3PO_4 produced a rougher surface than enamel treated with HCl.[9] The increased roughness observed with H_3PO_4 could be attributed to a less aggressive decalcification, producing a selective conditioning pattern on enamel surface, leaving a more granular and irregular surface.[9] They showed that the mean surface roughness was statistically lower for HCl than H_3PO_4 and deeper demineralization and a larger total demineralization area was observed for HCl. Similar results were observed by Mendes *et al*.[19] It seems that the H_3PO_4-pumice compound can be used safely in dental clinics and similar improvement in appearance will be obtained.

CONCLUSION

Results of this study showed:

Enamel microabrasion using HCl-pumice or H_3PO_4-pumice compound is effective and safe for removing enamel dysmineralizations and improves the appearance of the teeth; however, faster results are obtained with HCl-pumice compound.

All subjects (100%) reported to be very satisfied upon completion of the microabrasion treatment.

ACKNOWLEDGMENT

The authors wish to thank professors Mohammad Bagher Rezvani and Mohammad Reza Rouhollahi for their assistance in selection of patients and evaluation of photographs.

REFERENCES

1. DenBesten PK. Biological mechanisms of dental fluorosis relevant to the use of fluoride supplements. Community Dent Oral Epidemiol 1999;27:41-7.
2. Bezzerra AC, Leal SC, Otero SA, Gravina DB, Cruvinel VR, Ayrton de Toledo O. Enamel opacities removal using two different acids: An *in vivo* comparison. J Clin Pediatr Dent 2005;29:147-50.
3. Nevil BW, Dann DD, Allen CM, Bouquot J, editors. Oral and Maxillofacial Pathology. Philadelphia: Saunders, An Imprint of Elsevier Inc.; 2009. p. 54-8.
4. Lynch CD, McConnell RJ. The use of microabrasion to remove discolored enamel: A clinical report. J Prosthet Dent 2003;90:417-9.
5. Croll TP. A case of enamel color modification: 60-year results. Quintessence Int 1987;18:493-5.
6. Croll TP, Cavanaugh RR. Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Techniques and examples. Quintessence Int 1986;17:81-7.
7. McCloskey RJ. A technique for removal of fluorosis stains. J Am Dent Assoc 1984;109:63-4.
8. Croll TP. Enamel microabrasion: The technique. Quintessence Int 1989;20:395-400.
9. Miereles AA, Andre Dde A, Ledia FL, Bocnagel JS, Demarco FF. Surface roughness and enamel loss with two microabrasion techniques. J Contemp Dent Pract 2009;10:58-65.
10. Price RB, Loney RW, Doyle MG, Moulding MB. An evaluation of a technique to remove stains from teeth using microabrasion. J Am Dent Assoc 2003;134:1066-71.
11. Terry DA. A biomodification of tooth discoloration. Prac Proced Aesthetic Dent 2006;18:226-9.
12. Croll TP. Enamel microabrasion for removal of superficial dysmineralization and decalcification defects. J Am Dent Assoc 1990;120:411-5.
13. Segura A, Dooly KJ, Wefel JS. The effect of microabrasion on demineralization inhibition of enamel surfaces. Quintessence Int 1997;28:463-6.
14. Aoba T, Fejerskov O. Dental fluorosis: Chemistry and biology. Crit Rev Oral Biol Med 2002;13:155-70.
15. Paic M, Sener B, Schug J, Schmidlin PR. Effect of microabrasion on substance loss, surface roughness and colorimetric changes on enamel *in vitro*. Quintessence Int 2008;39:517-22.
16. Croll TP, editor. Enamel Microabrasion. Chicago: Quintessence; 1991. p. 27-60.
17. Donly KJ, O'Neil M, Croll TP. Enamel microabrasion: A microscopic evaluation of the "abrasion effect". Quintessence Int 1992;23:175-9.
18. Cvitko E, Swift EJ Jr, Denehy GE. Improved esthetics with a combined bleaching technique: A case report. Quintessence Int 1992;23:91-3.
19. Mendes RF, Mondelli J, Freitas CA. Avaliacao da quantidade de desgaste do esmate dentario subroetido a microabrasao. Rev FOB. 1999;7:35-40

How to cite this article: ???

Source of Support: Nil, **Conflict of Interest:** None declared.