IN BRIEF

- Easy to use classification of enamel opacities to determine whether microabrasion can improve the appearance of the disfigurement.
- Microabrasion works well with single line or patch types of enamel opacities, and the improvement is long term.
- Microabrasion is not effective in improving the appearance of multi-line and diffuse types of opacities.

Effectiveness of microabrasion technique for improvement of dental aesthetics

F. S. L. Wong¹ and G. B. Winter²

Objectives To investigate which types of enamel opacity are effectively treated by the microabrasion technique and whether this technique could be used as a diagnostic aid to determine the aetiology of these defects.

Materials and method Thirty two patients who had enamel opacities affecting both upper central incisors were selected and the disfigurements were classified into four types: single line, multi-line, patched and diffused. The patient's previous medical history, possible history of fluoride ingestion, presence of taurodontism and family history of similar enamel defects were recorded. Both incisors were treated with Préma abrasive paste mixed with 18% hydrochloric acid. The aesthetic improvements were assessed by the patients and their parents and their satisfaction level after the treatment was recorded.

Results Approximately two-thirds (65.6%) of the patients were satisfied with their appearance after microabrasion. Apart from four patients, the improved appearance was stable and acceptable to the remaining patients at the six month recall. Statistical analysis showed that acceptable improvement was found in patients with single line/patched types of defects but not in multi-line/diffused types ($P=0.03$). However, the aesthetic improvement was not related to the patient's fluoride history, presence of taurodontism or the family history of enamel defects.

Conclusion Microabrasion using Préma abrasives with 18% HCl is effective in improving the appearance of enamel with single-line or patched opacities, indicating that these defects are a surface phenomenon. For the multi-line and diffused types, the defects appear to extend deeper into the enamel. The technique failed to assist in determining the aetiology of these defects.

The aetiology of intrinsic discolouration of enamel may sometimes be deduced from the patient's history, and one factor long associated with the problem has been a high level of fluoride intake.¹ However, Small and Murray² drew attention to the fact that 97

other factors could be implicated in the causation of the defects and a more critical approach to the diagnosis of fluorosis was needed.³ When clinicians failed to find a definite cause, the term 'idiopathic dental fluorosis' was used to describe enamel with white or yellow/brown patches or spots. The use of the word 'fluorosis' in the diagnosis of these defects may be misleading, as was shown in a recent study.⁴ In this study, it was proposed that these defects may be a hypomaturational type of *amelogenesis imperfecta* (AI) because of an apparent association with taurodont permanent molars.

One technique of microabrasion mixes hydrochloric acid and an abrasive powder to remove the surface layer of the enamel. Only *et al.*⁵ showed that a dense prismless layer is formed on the abraded enamel surface giving the tooth a glass-like lustre appearance. This acid-microabrasion technique has been used as an initial treatment option to improve the disfigured enamel.⁶⁻⁹ Other techniques include the use of sandpaper discs or polishing burs (sometimes with guidance of microetching the enamel with phosphoric acid¹⁰) to remove the defective surface enamel. It has been reported that microabrasion could invariably make improvements to the disfigured enamel, but a proportion of the patients were still not satisfied with the change and requested further improvement by composite/porcelain veneers, crowns, or vital bleaching.¹¹⁻¹³ Hence, the aims of this study were to investigate which type of opacity could be aesthetically improved by microabrasion to an appearance acceptable to the patient and to explore whether this technique could also be used as an aid to determine the cause of the enamel defect.

MATERIALS AND METHOD

Patient selection

The patients were from two regional referral centres in North Thames, the Eastman Dental Hospital and the Dental Hospital of Barts and the London Hospitals NHS Trust. These patients suffered from disfigured incisor enamel, were displeased with their appearance, and requested treatment for the abnormality. In this study, only those who had defects in both upper central incisors and agreed to be treated with microabrasion were included. All the patients were treated by one of the authors (FW) over a period of four years (1991–1995).

For the selected patients, their medical histories, previous fluoride intakes (including possible ingestion from toothpaste) and

¹Senior Lecturer/Honorary Consultant, Paediatric Dentistry, Department of Oral Growth and Development, Barts and The London, Queen's School of Medicine and Dentistry.

²Emeritus Professor, Paediatric Dentistry, Eastman Dental Institute.

*Correspondence to: Ferranti S. L. Wong, Paediatric Dentistry, Department of Oral Growth and Development, Barts and The London, Queen's School of Medicine and Dentistry, Turner Street, London, E1 2AD, UK.

Email: f.s.l.wong@qmul.ac.uk

Refereed paper

Received 26.10.01; Accepted 02.04.02

© British Dental Journal 2002; 193: 155–158

their relatives having similar enamel disfigurements were ascertained. The presence of molar taurodontism was determined by direct tracings from rotational tomograms according to the landmarks and criteria of Holt and Brook.¹⁴

Microabrasion

Microabrasion treatment was based on the technique described by Croll.¹⁵ After the teeth were isolated with a rubber dam, Préma^{TM} (Premier Dental Products Co.) abrasive paste mixed with 18% hydrochloric acid was rubbed on the surface of the disfigured enamel using a hand applicator for 5–10 minutes with intermittent washing (Fig.1). At the end of the treatment, after thorough washing with copious water, the teeth were dried and 0.2 % sodium fluoride liquid was applied in order to enhance remineralisation. The patients were instructed not to rinse for one hour. This procedure was repeated after two weeks. The patients were then reviewed at six-monthly intervals. If they were unsatisfied with their appearance, a second course of treatment was carried out. After the second course, the remaining unsatisfied patients were treated with composite veneers.

Figure 1 Summary of the microabrasion technique.

- Isolate teeth with rubber dam
- Mix Préma abrasive paste with 18% HCl
- Apply the mixture with a hand applicator for 5–10 minutes on enamel surface
- Wash intermittently with water
- Apply 0.2% sodium fluoride on tooth surface
- Advise patient not to rinse for one hour

Aesthetic satisfaction

The aesthetic improvements were assessed by the patients and their parents. They were asked for their opinions immediately at the end of the first course of treatment (immediate improvement) and at the six-month review visit (long term improvement). For 'immediate improvement', the satisfied (S) group were those who thought the improvement was good enough and did not request further treatment, and the unsatisfied (US) group, those who wanted further treatment despite there being some improvement. For 'long term improvement', the long term satisfied (LS) group were those from the 'S' group who thought the improvement was stable, or from the 'US' group who thought their appearance had improved in the six months and requested no further treatment; whereas the long term unsatisfied (LU) group were those from the 'S' group who thought the appearance had deteriorated in the six months and requested further treatment, or from the 'US' group who were still unhappy about their appearance. The clinician did not attempt to influence the patients' decisions at any stage of the procedures.

Classification of enamel opacity

The colours of the affected enamel were divided to either yellow or white compared with the underlying colours of the normal enamel. The patterns of opacity were divided in four groups : (1) single line (SL, Fig. 2a) – a linear horizontal defect which was less than 2 mm wide; (2) multi-line (ML, Fig. 2c) – multiple horizontal line defect with each line less than 2 mm in width; (3) patched (PA, Fig. 2e) – a defect which covered a single area with each side more than 2mm and; (4) diffused (DF, Fig. 2g) – small discontinuous area defects.

Statistical analysis

The relationship between the patient's satisfaction and their sex, pattern of opacities, defect colour, excessive fluoride ingestion, presence of taurodont molars, and long term satisfaction were tested. Because the sample size was small, Fisher's Exact Test was used and it was regarded as significant if the *P* value was less than 0.05. Those patients who had an uncertain history of fluoride ingestion were excluded from the test.

Figure 2 Clinical photographs showing the 4 types of defects before and 6 months after treatment.

RESULTS

The case histories and treatment outcomes for the 32 patients are summarised in Table 1. The distribution of male (44%) and female (56%) patients were similar. A high proportion of the defects had single line (31%) or patched (47%) patterns with predominantly yellow (69%) discolouration. Thirteen patients (41%) had a history of excessive fluoride intake, 14 (44%) had no known history of excess fluoride intake, and five were not sure. Eighteen patients (56%) had at least two permanent molars that had taurodontism, mainly in the maxilla. Three pairs of the patients were siblings (cases 17–18, 26–27, and 29–30). Four patients had known relatives who also had enamel disfigurement.

For the outcome of treatment, approximately two-thirds of the patients (65.6%) were satisfied with their appearance immediately after microabrasion. Apart from four patients (3 females and 1 male, cases 3, 7, 20, and 23), the improved appearance was stable and still acceptable to these patients at the six month recall. One male patient (case 28) who was dissatisfied with the initial improvement thought the appearance had improved after six months. Table 2 shows that the patients were satisfied with the immediate improvement if their defects were single line or patched, but if the defects were multi-line or diffused, the patients were not satisfied with the treatment improvement ($P=0.03$). Also, there was a significant relationship between immediate and long

Table 1 Case records of patients with enamel defects

Case no.	Sex	Pattern of opacities	Defect colour	Excess Fluoride	Taurodontism	Affected sibling	Immediate improvement	Long term improvement
1	M	SL	Y	No	None	No	S	LS
2	F	ML	W	Yes	UR7, UR6, UL6 LL7, LR7 (17, 16, 26, 37, 47)	No	U	LU
3	F	PA	W	No	UR6, UL6 (16, 26)	No	S	LU
4	M	SL	Y	No	UR7, UR6, UL7 (17, 16, 27)	Father and Grandmother	S	LS
5	F	DF	W	Yes	UR6, UL6 (16, 26)	1 Brother	S	LS
6	M	SL	Y	Not known	None	Not known	S	LS
7	F	SL	Y	Yes	UR7, UR6, UL6, UL7 (17,16,26,27)	1 Sister	S	LU
8	M	PA	Y	Yes	None	No	S	LS
9	M	SL	Y	Yes	UR6, UL6 (16, 26)	No	S	LS
10	F	PA	W	Not known	UR6, UL6 (16, 26)	No	U	LU
11	F	PA	Y	No	UR6, UL6 (16, 26)	No	S	LS
12	F	PA	W	Yes	UR6, UL6 (16, 26)	1 Brother	S	LS
13	F	S	LY	Yes	None	No	S	LS
14	F	PA	W	Yes	UR6, UL6, LL6, LR6 (16, 26, 36, 46)	No	S	LS
15	F	PA	Y	Yes	UR7, UL6, UL7 (17, 26, 27)	No	S	LS
16	F	PA	W	No	Not recorded	No	U	LU
17	M	PA	Y	Yes	UR7, UR6, UL7 (17, 16, 27)	1 Brother (case 18)	U	LU
18	M	DF	W	Yes	UR7, UR6, UL6, UL7 (17, 16, 26, 27)	1 Brother (case 17)	U	LU
19	F	PA	Y	Yes	Not recorded	No	U	LU
20	F	PA	Y	No	UR7, UR6, UL7 (17, 16, 27)	No	S	LU
21	M	PA	W	Not known	UR7, UL7 (17, 27)	1 Sister	U	LU
22	F	SL	Y	Not known	UR7, UL7 (17, 27)	No	SL	S
23	M	SL	Y	No	None	No	SL	U
24	F	SL	Y	No	None	1 Brother	S	LS
25	M	DF	W	Not known	UR7, UL7 (17, 27)	No	UL	U
26	M	ML	Y	No	UR7 UL7 (17, 27)	1 Sister (case 27)	UL	U
27	F	ML	Y	No	None	1 Brother (case 26)	U	LU
28	M	ML	Y	No	None	No	UL	S
29	F	PA	Y	No	None	1 Brother (case 30)	S	LS
30	M	PA	Y	No	None	1 Sister (case 29)	S	LS
31	F	PA	Y	Yes	None	No	S	LS
32	M	SL	Y	No	None	No	S	LS

SL=single line, ML= multi-line, PA=patched, DF=diffused, Y = yellow, W=white, S=satisfied, US=unsatisfied, LS=long term satisfied, LU=long term unsatisfied

term satisfaction ($P < 0.01$). However, sex, defect colour, taurodontism and history of excess fluoride ingestion was not related to the treatment outcome.

DISCUSSION

Aesthetics is a subjective perception. Some authors who used an index with an arbitrary cut-off to designate classes of defects as aesthetically objectionable may not reflect the communities', nor the individuals' perception of cosmetic acceptability.¹⁶ Also, the aesthetic values of the dentist may not reflect those of the patient. Hence, in this study, no aesthetic index was used. Instead, the patient's and their parent's satisfaction of the improvement was regarded as a successful outcome. In a population study, it could be argued that girls may be more concerned with their appearance than boys. In this study, the patients who attended the clinic were self selected because they were not happy with their disfigured incisors. Table 2 shows that there were similar number of boys and girls who had the treatment and their gender did not influence their satisfaction level after the treatment.

Table 2 also shows that the microabrasion technique was effective in improving the appearance of defects that are classified as single line or patched (SL+PA, Figs 2b and 2f) but not for multi-line (ML, Fig 2d) or diffused (DF, Fig 2h) types. A single line defect

usually implies that a group of ameloblasts with the same functional age are disrupted at roughly the same time during development of the crown. Although the patched type covered a larger area, it can be regarded as a continuation of the single line type with a more prolonged disturbance, so they could be grouped together as one entity. For the DF type of defect, it can be postulated that the ameloblasts were affected randomly. As the whole surface of the tooth was affected, it is likely that the cause exerted an influence throughout the whole period of crown development. However, this aetiological factor may not be strong enough to affect the whole population of ameloblasts and some recovered to produce normal enamel. It is debatable in which category the ML type of defect should be placed as it is a combination of both line and diffused defect. Clinically, it was difficult to distinguish from the diffused type, and therefore, was grouped with the diffused type as one entity. This time-related hypothesis may explain the difference in the satisfaction level. For the single line and patched types, the insult to the ameloblasts was in a specific time period (prolonged period for the patched type), the distribution of the hypomatured enamel followed a pattern illustrated by Fejerskov *et al.*¹⁷ This pattern starts with a surface layer which extends under the surface towards the cervical region. As the action of microabrasion is to remove the first 100–200 µm of surface enamel (depending on the time and pressure of application^{18,19}), the objec-

Table 2 Association between successful treatment outcome and other factors

		Immediate improvement		Total	Significance (Fisher Test)
		Satisfied	Unsatisfied		
Sex	M	8	6	14	0.47
	F	13	5	18	
Pattern of opacities	SL+PA	20	5	25	0.03
	ML+DF	1	6	7	
Defect Colour	Yellow	17	5	22	0.11
	White	4	6	10	
Excess Fluoride*	Yes	9	4	13	1.00
	No	9	5	14	
Taurodontism	Absence	10	2	12	0.25
	Presence	11	7	18	
Long term improvement	LS	17	1	18	<0.01
	LU	4	10	14	

* 5 patients had unknown fluoride history and were excluded from the test

tionable disfigured tissues would be removed, exposing the normal enamel underneath. Hence, the patient would be content with the improved appearance. Also, since the newly exposed enamel was normal, the stability of the improved appearance would be long term (Table 2). For the multi-line and diffused types, the defects are likely to extend to a considerable depth into the enamel, therefore, removing the surface layer by microabrasion could not improve the appearance significantly. Comparing the clinical appearance of the enamel in this study with that in Thylstrup and Fejerskov,²⁰ there are similarities between the defects and the fluorosis index. The PA defect was similar to score 3 in the Thylstrup and Fejerskov classification; whereas the ML and DF defects were similar to score 4. These authors showed that score 3 had subsurface porous enamel that was about 80–100 µm deep, and score 4 had a pore volume of about 10–25%. If these defects were caused by fluorosis, then it confirms that microabrasion is only effective in the improvement of minor surface defects. If the opacities are too deep or the teeth are hypoplastic, microabrasion would not be the treatment of choice to improve the appearance. For the SL defect, the appearance did not have a corresponding score. However, for the reason discussed above, it could be regarded as a minor form of the PA defect.

The colour of the defect did not seem to give any additional information on the cause of the anomaly. The difference in the colour may only be the difference in the extent to which the

porous enamel takes up the stain, most likely post-eruptively. Therefore, it cannot be used to determine whether the defect is a surface phenomenon or not.

As the study did not find an association between the ingestion of excess fluoride or the presence of taurodontism and the success of treatment, it remains difficult to differentiate between fluorosis and *amelogenesis imperfecta* on the basis of microabrasion procedures. However, in this study, the diagnosis of *amelogenesis imperfecta* (AI) was not certain as it relied principally on the presence of taurodontism as the diagnostic indicator. More sophisticated methods such as that offered by molecular genetic techniques will be required to identify the patients with AI before more firm conclusions can be drawn.

1. Churchill H V. The occurrence of fluorides in some waters of United States. *J Induct Engin Chem* 1931; **23**: 996–998.
2. Small B W, Murray J J. Enamel opacities: prevalence, classifications and aetiological considerations. *J Dent* 1978; **6**: 33–42.
3. Cutress T W, Suckling G W. Differential diagnosis of dental fluorosis. *J Dent Res* 1990; **69** (Special Issue): 714–720.
4. Winter G B. Amelogenesis imperfecta with enamel opacities and taurodontism: an alternative diagnosis for 'idiopathic dental fluorosis'. *Br Dent J* 1996; **181**: 167–172.
5. Donly K J, O'Neill M, Croll T. Enamel microabrasion: a microscopic evaluation of the 'abrosion effect'. *Quintessence Int* 1992; **23**: 175–179.
6. Croll T P, Cavanaugh R R. Enamel color modification by controlled hydrochloric acid-pumice abrasion. I. Technique and examples. *Quintessence Int* 1986; **17**: 81–87.
7. Croll T P, Cavanaugh R R. Enamel color modification by controlled hydrochloric acid-pumice abrasion. II. Further examples. *Quintessence Int* 1986; **87**: 157–164.
8. Train T E, McWhorter A G, Seale N S, Wilson C F, Guo I Y. Examination of esthetic improvement and surface alteration following microabrasion in fluorotic human incisors *in vivo*. *Pediatr Dent* 1996; **18**: 353–362.
9. Elkhazindar M M, Welbury R R. Enamel microabrasion. *Dent Update* 2000; **27**: 194–196.
10. Pourghadiri M, Longhurst P, Watson T F. A new technique for the controlled removal of mottled enamel: measurement of enamel loss. *Br Dent J* 1998; **184**: 239–241.
11. Kilpatrick N M, Welbury R R. Hydrochloric acid/pumice microabrasion technique for the removal of enamel pigmentation. *Dent Update* 1993; **20**: 105–107.
12. Croll T P, Segura A. Tooth color improvement for children and teens: enamel microabrasion and dental bleaching. *ASDC J Dent Child* 1996; **63**: 17–22.
13. Croll T P, Helpin M L. Enamel microabrasion: a new approach. *J Esthet Dent* 2000; **12**: 64–71.
14. Holt R D, Brook A H. Taurodontism: a criterion for diagnosis and its prevalence in mandibular first permanent molars in a sample of 1,115 British schoolchildren. *J Int Assoc Dent Child* 1979; **10**: 41–47.
15. Croll T P. Enamel microabrasion for removal of superficial dysmineralization and decalcification defects. *J Am Dent Assoc* 1990; **120**: 411–415.
16. Ellwood R P, O'Mullane D. Enamel opacities and dental esthetics. *J Public Health Dent* 1995; **55**: 171–176.
17. Fejerskov O, Thylstrup A, Larsen M J. Clinical and structural features and possible pathogenic mechanisms of dental fluorosis. *Scand J Dent Res* 1977; **85**: 510–534.
18. Tong L S, Pang M K, Mok N Y, King N M, Wei S H. The effects of etching, micro-abrasion, and bleaching on surface enamel. *J Dent Res* 1993; **72**: 67–71.
19. Dalzell D P, Howes R I, Hubler P M. Microabrasion: effect of time, number of applications, and pressure on enamel loss. *Pediatr Dent* 1995; **17**: 207–211.
20. Thylstrup A, Fejerskov O. Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dent Oral Epidemiol* 1978; **6**: 315–328.