

## ABSTRACT

## Microabrasion to improve aesthetics

The article focuses on minimally invasive treatment to improve aesthetics, with particular emphasis on the microabrasion technique. Background and a practical guide are given. Clinical cases with different diagnoses and treatment choices are presented. Other minimally invasive techniques such as bleaching and infiltration are also shortly discussed. When considering the clinical procedures, results, longevity and side effects of available minimally invasive treatment approaches, the microabrasion technique alone or in combination with a bleaching procedure is a promising method. It is a well proven, safe, quick and inexpensive treatment of poor aesthetics caused by enamel opacities/staining due to fluorosis (TF scores 1-3). When it comes to opacities due to molar incisor hypomineralisation (MIH) and white spot carious lesions, the results are more uncertain. In some cases, alternative procedures like resin infiltration or invasive treatment like veneers may be required.

# Microabrasion: a minimally invasive technique to improve aesthetics

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The microabrasion technique has been known and used for many decades to remove opacities and staining, particularly in USA within areas with a high prevalence of fluorosis. The term “micro” originates from the Greek *mikrós* -small and “abrasion” from the Medieval Latin abrasion -scraped off. As this term suggests, the technique is minimally invasive, preserving healthy enamel and thereby in line with modern strategies for dental treatment. Microabrasion may therefore be the first choice to consider for treating teeth with poor aesthetics due to enamel opacities and/or staining of different origin. Although the technique is known among some clinicians, it still has no widespread use. The purpose of this paper was to give background information and a detailed practical guide to the technique in order to make it known to more clinicians in general. Clinical cases with different diagnoses and treatment choices are presented (Fig.1-5) and alternative minimally invasive techniques to improve aesthetics will also shortly be discussed.

### The microabrasion technique in the past

The technique by which fluorosis stains (“The Colorado Brown Stain”), was removed by an acid was first developed in 1916 by Walter Kane, a dentist from Colorado Springs, USA. He used 36% hydrochloric acid (HCl) and heat to force the acid into the enamel. The results were satisfactory. After experimenting with

### KEYWORDS

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different acidic solutions he ended up using only HCl without any additional heat (1). The other dentists in the area considered his work as radical and dangerous and feared that this



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treatment would cause the teeth to dissolve completely. As a result, Kane never published his results and the method received little appreciation and no widespread use despite 60 years of use in the Colorado Springs area (2). In order to improve the safety of the use of HCl for removing stains in enamel, the concentration was later lowered to 18% and applied with a wooden spatula covered by cotton for a maximum of 10 minutes, followed by application of sodium bicarbonate to neutralize the effects of the acid (3).

In 1984 the work by Kane was further developed by McCloskey, who reported that 18% HCl gave good results without any damage to the teeth (1). The acid was applied to the stained labial tooth surfaces with a steel instrument wrapped in cotton and with linen strips in the interproximal areas. In the end, pumice was added to the acid and applied with a rubber prophylaxis cup rotating at less than 2000 rotations per minute. The author concluded that fluorosis stains could be removed permanently using this simple and fast procedure with no patient discomfort. Later this method was further modified; first by using a slurry made by adding pumice to 36% HCl (4) and then developed into what is known today as the microabrasion technique using 18% HCl and pumice in a slurry, applied either by scrubbing with a wooden stick or with a slow rotation hand-piece to avoid scattering of the slurry (5). It has also been proposed to use an extra fine diamond bur prior to the use of the microabrasive agent to reduce the procedure working time (6).

### Microabrasion and bleaching

The method of bleaching mottled enamel by the use of different approaches has also been investigated. It has been argued that the use of acids to remove stains cause decalcification of enamel, making the teeth more susceptible to caries. Therefore, an alternative method where a bleaching solution consisting of 30% hydrogen peroxide ( $H_2O_2$ ) and ether applied with a heated instrument was recommended (7). Another suggested method was a combination of 30%  $H_2O_2$ , 36% HCl and diethyl ether applied with a cotton tip applicator (8), followed by neutralization with a paste of sodium bicarbonate ( $NaHCO_3$ ) and water. Another version of this method has also been used where alcohol was applied to the tooth surfaces, followed by the bleaching solution (30%  $H_2O_2$ , 36% HCl and ether) using fine sandpaper discs moistened with water. In the end, the teeth were neutralized by 5.25% sodium hypochlorite and solution had to be freshly made each time, the use of cotton tip gives little pressure, the patients experienced discomfort and the effect was temporary, meaning that the treatment would have to be repeated.

### Microabrasion nowadays

The technique mostly preferred nowadays is based on the method described by Croll (10), and involves application of the acid paste and scrubbing of the affected areas (Fig.6). By the combination of chemical erosion plus mechanical abrasion, the outermost enamel surface layer can be removed. It is claimed

### Localised hypomineralisations



**Fig. 1.** A 15 year old girl with labial opacities on teeth 11 and 21 (upper photo) diagnosed as localized hypomineralisation. The appearance of the affected teeth was improved after removal of the opacities by the microabrasion technique (Fig.6; scrubbing the affected areas with a slurry consisting of 18% hydrochloric acid and pumice and remineralization by 2 % fluoride solution in the clinic, succeeded by daily rinse at home with 0.2 % fluoride solution for four weeks for remineralisation of the enamel surfaces) (lower photo). The author ABT performed the treatment.

*Fig. 1. En 15 år gammel pige med hvide opaciteter bukkalt på 1+ og +1, som blev diagnosticeret som lokale hypomineraliseringer med ukendt årsag (øverste foto). De afficerede områder blev behandlet med mikroabrasion i henhold til proceduren i Fig.6 med godt resultat (nederste foto). Behandlingen blev udført af forfatteren ABT.*

to be a safe, efficient and atraumatic method to remove superficial enamel defects in the form of hypomineralisation and minimal hypoplasia (11).

It has been shown that the mean enamel thickness on the buccal surfaces of the maxillary incisors is 1 mm in the incisal area and  $0.5 \mu m$  in the cervical area (12). One investigation showed that after 5 x 5 seconds application of 18% HCl with pumice,  $\sim 40 \mu m$  of the enamel was removed, and after 10 x 5 seconds applications the depth was  $\sim 70 \mu m$  (13). Other inves-

## Localised hypomineralisations



**Fig. 2.** A 18 year old woman who complained about the appearance of her maxillary central incisors and demanded perfect veneers (upper photo). The existing discoloured and fractured composite veneers were gently removed. Diffuse opacities in the otherwise intact enamel surface were revealed underneath consistent with the diagnosis Dental Fluorosis TF score 3 (middle photo). In order to remove the opacities, the lateral and central incisors were treated with the microabrasion technique (Fig.6). The enamel appeared slightly yellow afterwards and at home bleaching; 2 hours per day for a week with 20 % carbamide peroxide, was carried out (lower photo). The author KRS performed the treatment.

**Fig. 2.** En 18-årig kvinde som klagede over udseendet på incisiverne i overkæben og ønskede perfekte laminater (øverste foto). De misfarvede og frakturerede kompositfacader blev forsigtigt fjernet. Emaljeoverfladen nedenunder var intakt, men havde hvide/gule opaciteter, som sammen med anamnesen gav diagnosen dental fluorose TF score 2-3 (midterste foto). Opaciteterne på laterale og centrale incisiver blev fjernet med mikroabrasion (Fig.6). Emaljen fremstod som gul efter behandlingen og de nævnte tænder blev derfor bleget hjemme; to timer per dag i en uge. Dette resultat er permanent, og patienten er meget tilfreds med resultatet (nederste foto). Behandlingen blev udført af forfatter KRS.

tigations found more enamel loss;  $\frac{1}{4}$  of the enamel thickness (14). The total amount of enamel that is removed is not crucial as long as the remaining thickness is able to protect the underlying dentin and not lead to reduced strength and aesthetics (13). Another advantage of the microabrasion technique is that it is relatively fast to perform (30-40 minutes depending on the number of teeth), there is no need of anaesthesia and it is inexpensive. It is apparent that the 18% hydrochloric acid-pumice mixture has the potential to remove white enamel opacities, multi-coloured defects, and many brown, orange and yellow enamel spots and streaks limited to a thin layer of the tooth surface, regardless of the aetiology (10). As a result, there is little to lose by beginning the treatment of enamel stains of uncertain depths by enamel microabrasion. These reports are in line with the author's clinical experience that this technique may be the best method to remove aesthetically disturbing opacities occurring in mild dental fluorosis; Thylstrup and Fejerskov (TF) score 1-3. More distinct opacities, often in combination with brown staining occurring in moderate dental fluorosis; TF score 4-5(6) and minor pits, can also be modified but not always eliminated by this technique.

It is recommended that teeth are bleached afterwards, if the fluorosis discolouration cannot be removed by microabrasion alone (15) or if the teeth appear yellow after the removal of the outermost fluorosis enamel layer and/or the colour of the dentin is seen through the thinner enamel (13,14). Further improvement in aesthetics can then be obtained by bleaching (15,16).

In addition to fluorosis, indications for the use of the microabrasion technique can be hypomineralisation related to Molar Incisor Hypomineralisation (MIH) and localized hypomineralisation in the front teeth as a result of caries or trauma/illness. It has also been reported that the microabrasion technique is effective and should be recommended to improve poor aesthetics due to occurrence of white spot caries lesions for instance after orthodontic treatment (17,18). Enamel opacities can be white, yellow or brown. The yellow and brown opacities often affect the whole enamel thickness, while the white opacities vary in thickness (19). It has been reported that yellow and brown opacities may respond well to bleaching with carbamide peroxide (20) and the white opacities in the outer layer may be removed by microabrasion (21,22). However, the best result will often be obtained by a combination of these two treatments. Based on the authors experience with 44 patients with severe fluorosis bleaching only of brown opacities does not give a satisfactory result.

#### Long-term results

Even though there are few studies with long term evaluation of the result of microabrasion and mostly describing a limited number of patient cases, it has been stated that since the discoloured enamel is actually removed the result will be permanent (10). Some reports have evaluated cases up to 23 years after microabrasion and it was concluded that the technique is highly satisfactory, safe and effective (23,24). In addition it has been stated that it is extremely acceptable to the patient (25).



## Localised white hypomineralisations with brown staining



**Fig. 3.** A 22 year old woman showing localized hypomineralisation in the form of labial diffuse opacities of white and brown colour on teeth 11 and 21 (upper photo). The affected teeth were treated with the microabrasion technique (Fig.6) leading to a satisfactory result (lower photo).The treatment was performed by the authors ABT and KRS.

**Fig. 3.** En 22-årig kvinde med hypomineralisering manifesteret som hvide og brune opaciteter bukkalt på 1+ og +1 (øverste foto). De afficerede tænder blev behandlet med mikroabrasion (Fig.6), som gav et tilfredsstillende resultat(nederste foto). Behandlingen blev udført af forfatterne ABT og KRS.

Tooth bleaching cannot remove the white opacities on teeth affected by fluorosis; they may even appear whiter and more visible after bleaching. However, bleaching after microabrasion can give more homogenous and whiter teeth, and is recommended if microabrasion alone cannot remove the opacities (15). For the bleaching procedure, products with hydrogen peroxide or carbamide peroxide can be used at home in low concentration. One has to follow the directive from the European Union regarding tooth bleaching; products containing > 0.1% and ≤ 6% hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) can be introduced by a dentist only for at home bleaching. Concentrations above 6% H<sub>2</sub>O<sub>2</sub> is only for use in the clinic. Also the user must be ≥ 18 years old (26). Vital bleaching in the clinic by the use of 35%

## CLINICAL RELEVANCE

The purpose and clinical relevance of this article is to make the microabrasion technique known to clinicians as a treatment option. The technique is minimally

invasive which is in line with modern treatment strategies and may be the first choice to improve poor aesthetics in patients due to opacities and staining of different aetiology.

hydrogen peroxide (27-30) is also a frequently used method to obtain optimal colour of the teeth after microabrasion. There are no long-term studies on the effect of bleaching agents like peroxide on oral tissue, especially the pulp, but preliminary results from a prospective study indicate that ~ 50% of the patients suffered from side effects of the bleaching procedure; mostly hypersensitivity (31). The results from a multi-centre practice based study on side effects of external tooth bleaching, showed a high prevalence of side effects; mostly reversible, but some patients suffered up to one year after treatment (32). The prevalence of tooth sensitivity was independent of an at-home or in-clinic procedure, where gingival irritation was higher after in-office bleaching. In an *in vitro* study where extracted teeth were bleached, no significant differences were found if light was used as part of the treatment. This finding, together with the risk of negative side effects of the exposure to light, has led to a general advice not to use light when bleaching (33).

The prognosis for a satisfactory result after external bleaching on a general basis varies in each case. Studies with electron microscopy have shown that vital bleaching may lead to porosities and cracks around the enamel prisms and exposed prisms (34). These changes in the enamel surface are dependent on the duration of the bleaching process. Relapse is most commonly caused by discolouration of the newly treated porous tooth surface.

### Alternative techniques

Minimally invasive techniques other than microabrasion are also in use for improving the aesthetics of teeth with opacities and staining. One of these is the McInnes solution (5 parts 30% H<sub>2</sub>O<sub>2</sub>, 5 parts 18% HCl and 1 part ethyl ether), combining chemical abrasion and bleaching in one fluid (8). In a recent study, the traditional microabrasion technique (18% HCl mixed with fine pumice powder, applied with a slowly rotating rubber cup) and the use of McInnes solution were compared in 30 patients (9-14 years old) with mild to moderate fluorosis according to Dean's index (35). It was concluded that both techniques are conservative and safe, but that the immediate and long-term (6 months) aesthetic improvement by the use of McInnes solution was superior to the use of enamel microabrasion. One may argue that the result of the traditional enamel

## Dental fluorosis TF3-4 and MIH



**Fig. 4.** A 16 year old boy who complained about the speckled appearance of his front teeth (upper photo). The white opacities were diagnosed as Dental Fluorosis TF score 3-4 in combination with Molar Incisor Hypomineralisation (MIH) due to brown hypomineralisation and posteruptive breakage of the whole occlusal surface of tooth 16 and the large demarcated opacity on tooth 11. In order to remove the opacities, upper and lower front teeth (13 to 23 and 33 to 43) were treated with the microabrasion technique (Fig.6). At the control four weeks later, the enamel appeared yellow compared to the lateral teeth. At home bleaching; 2 hours per day for two weeks with 20 % carbamide peroxide, was therefore carried out leading to a satisfactory result (lower photo). The treatment was performed by the authors ABT and KRS.

**Fig. 4.** En 16-årig dreng som klagede over, at fortænderne var grimme og uens i farven (øverste foto). De hvide opaciteter blev diagnosticeret som Dental Fluorose TF score 3-4. Samtidig blev diagnosen MIH stillet, fordi patienten havde en brun hypomineralisering med posteruptivt brud på hele okklusallfladen på 6+ og den store markerede opacitet på 1+. Mikroabrasion blev udført på alle for- og hjørnetænder i over- og underkæbe for at fjerne opaciteterne. Tænderne fremstod som gule efter behandlingen, og patienten udførte hjemmeblegning to timer per dag i to uger (med 20 % karbamid peroxid), og dette gav et godt resultat (nederste billede). Patienten syntes ikke, det var nødvendigt med mikroabrasion af præmolarerne. Behandlingen blev udført af forfatterne ABT og KRS.

microabrasion in that study may have been further improved if it had been succeeded by “at-home bleaching”. The authors reported negligible side effects of both techniques, such as hypersensitivity of the treated teeth; subsiding within one month postoperatively. Disadvantages of bleaching methods like McInnes solution have previously been emphasized; the solution has to be freshly made each time, the use of cotton tip gives little pressure, the patients experience discomfort and the effect was temporary, meaning that the treatment would have to be repeated (1). At least in young teeth with wide dentin channels, the use of 30% hydrogen peroxide may introduce a risk of side effects that has to be considered.

Recently, a new approach for the treatment of initial caries without cavitation was introduced. The principle for this minimally invasive technique is to infiltrate the demineralized and porous enamel using a resin (36,37). According to the manufacturer one of the indications for use is; «Micro-invasive treatment of smooth surface enamel lesions; cariogenic white spots». The strategy is to mask these by infiltration with a low-viscosity resin which has a similar refractory index to sound enamel.

There are few studies to support the longevity and stability of this treatment over time, but in a Randomized Clinical Study it was concluded that the resin infiltration of «white spot lesions» improved the aesthetics of demineralized teeth with sufficient longevity of over 6 months (38). The same conclusion was made after a 19 months follow-up of such lesions (39). There are also some studies reporting significant improvement in aesthetics where resin infiltration has been used to mask opacities caused by mild to moderate fluorosis (40), but the treatment was not compared with the microabrasion technique. In a case report a modified infiltration procedure was used where the affected areas were initially bleached in the clinic (40% H<sub>2</sub>O<sub>2</sub>) before the infiltration was performed (41). The authors concluded that resin infiltration is a more agreeable option than more invasive, conventional procedures, but also that long-term results must be further evaluated. The success over time depends on the penetration depth, mechanical impact on the surface and degradation of the resin. Since the infiltrating agent consists of a methacrylate-based resin, there is a risk of yellow discoloration over time. In addition, if a complete seal is not obtained,

## Dental fluorosis TF3staining



**Fig. 5.** A young woman with diffuse white opacities and secondary brown staining was not satisfied with the appearance of her upper front teeth (upper photo). The clinical findings were diagnosed as Dental Fluorosis TF score 3. The teeth 12-22 were treated with the microabrasion technique (Fig.6) (lower photo).The treatment was performed by the authors ABT and KRS.

**Fig. 5.** Ung kvinde med hvide opaciteter og brun misfarvning; diagnose Dental Fluorose TF score 3. Hun var utilfreds med tændernes udseende. Der blev udført mikroabrasion på alle incisiver i overkæben med godt resultat. Behandlingen blev udført af forfatterne ABT og KRS.

extrinsic discolouration may adhere or penetrate the demineralized area. The colour stability of the infiltration has been evaluated in studies with different results. One study showed that the resin infiltration led to more discolouration than other products (42). In contrast, another study found that when comparing treatment of white spot lesions with microabrasion to infiltration *in vitro*, both reduced the white appearance, but only the infiltrated lesions were colour stable under the impact of black tea or black tea and citric acid (43). The authors speculated that the reason for this was that microabrasion of enamel with 6.6% HCl, may not have been sufficient to remove the whole porous layer or that the surface becomes and stays rough

## Procedures of the microabrasion technique

- 1) Isolate the teeth with rubberdam to protect gingiva against acid. Add rubberdam flow on uncovered gingiva if necessary.
- 2) Mix a paste with pumice (without glycerol) and 18% hydrochloric acid\*.
- 3) Add a small amount of paste on the affected area and use a wooden match or dental stick to scrub the affected opaque area for maximum 5 seconds.  
NB! Work on one tooth at a time to control the working time!
- 4) Rinse well with water spray and use vacuum. Inspect the tooth surface.
- 5) Repeat this procedure for a maximum of 10 x 5 seconds until a satisfactory result is obtained.  
NB! Stop in time if the enamel seems thin!
- 6) Apply 2% Sodium Fluoride (NaF) solution\*\* on the enamel surface for 3-4 minutes for remineralisation and then remove the rubberdam.
- 7) Advise the patient to rinse with 0.2% NaF mouthwash in the morning and evening for at least one month to enhance remineralisation of the enamel surface.
- 8) Evaluate the result after at least 4 weeks and determine if bleaching is required.

\*18% HCl-mix distilled water and 36% HCl (MW = 36.46 ginol)

\*\* 2% NaF solution: 2 g NaF (MW = 42 g/mol) and 100ml distilled water)

**Fig. 6.** A practical guide to the microabrasion technique.

**Fig. 6.** Procedure for udførelse af mikroabrasion.

after the treatment. However, the authors emphasized that this was an *in vitro* study and therefore could not replicate the actual mode of colour improvement and stability. In contrast, in the clinical situation the microabraded surface layer will remineralise and become hard and shiny if the patients follow the recommendations to keep the surface free of plaque and use fluoride mouth rinse for at least a month after the traditional procedure. One must also bear in mind that the resin infiltration technique is expensive and since all upper and lower front teeth will need treatment, at least for fluorosis; micro-abrasion may be a better option to improve aesthetics.

## Conclusion

When considering the clinical procedures, results, longevity and side effects of different minimally invasive treatment options, it seems that the traditional microabrasion technique alone or in combination with a bleaching procedure is a safe, quick and inexpensive treatment for enamel opacities. It may sometimes be difficult to predict the degree of success for the results, but one should always take the microabrasion technique into consideration as the first treatment of choice. Clinical experience and many reports have demonstrated that it is most often successful, but in some cases resin infiltration or invasive treatment like veneers, may be required.



## ABSTRACT (DANSK)

**Mikroabrasion for forbedret æstetik**

Denne artikel omhandler tandbesparende teknikker til opnåelse af forbedret æstetik og fokuserer især på mikroabrasionsteknikken. Der præsenteres en historisk oversigt over brugen af denne teknik samt en praktisk vejledning. Andre metoder som blegning og infiltration bliver også kommenteret. Artiklen præsenterer kliniske tilfælde med behandlingsforslag. Mikroabrasionsteknikken er en

gennemprøvet, enkel, sikker og rimelig behandling af opaciteter og misfarvninger, som skyldes dental fluorose (TF score 1-3). Den kan også give gode resultater ved opaciteter som følge af MIH eller kronisk caries i emaljen; men erfaringerne inden for dette område er sparsomme. I nogle tilfælde må man ty til alternativ behandling med infiltration, komposit eller laminat, hvis behandling med mikroabrasion ikke lykkes.

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