Er:YAG laser etching of hypoplastic enamel

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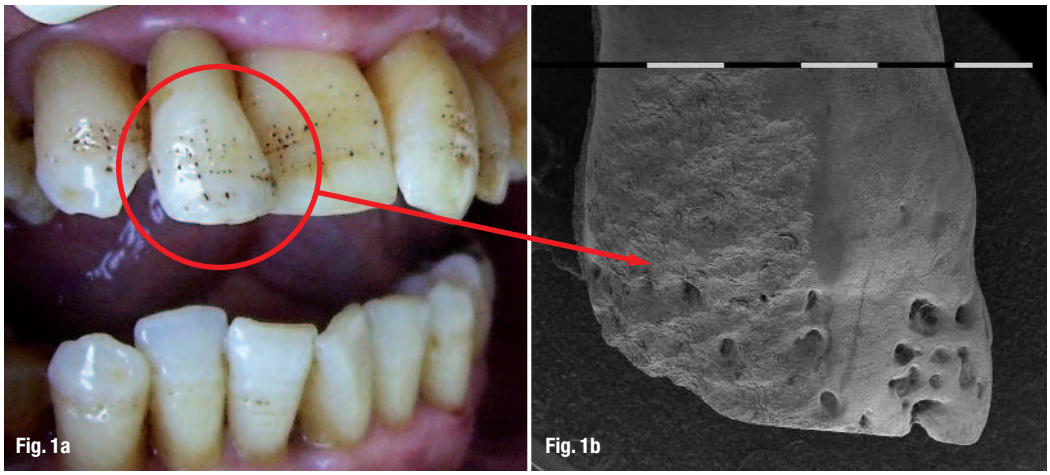


Fig. 1_Dentition represents a pitted hypoplastic variant of EH **(a)**. The extracted tooth is treated with 37% phosphoric acid for 600 sec (right side) and irradiated by Er:YAG radiation (LiteTouch 200 mJ/355 Hz, left side) and then examined under SEM **(b)**.

_Introduction

Enamel hypoplasia is the most common abnormality of development and mineralisation of human teeth. The lesion is characterised by a quantitative defect in enamel tissue resulting from an undetermined metabolic injury to the formative cells – the ameloblasts.[1] Clinically, enamel hypoplasia is seen as a roughened surface with discreet pitting or circumferential band–like irregularities which posteruptively acquire a yellow brown stain.[1] Enamel hypoplasia is endemic in many countries of the world and is commonly reported in association with disease of childhood. The hypoplastic enamel has differences in structure and composition that may affect it's etching patterns.[2] Enamel etch by the acid can be additionally complicated by variability of penetration depth, and strong washing and drying affecting the bond strength.[3] Er:YAG lasers are discussed as an alternative of acid etching, but there are no scientific evidences to support this hypothesis.

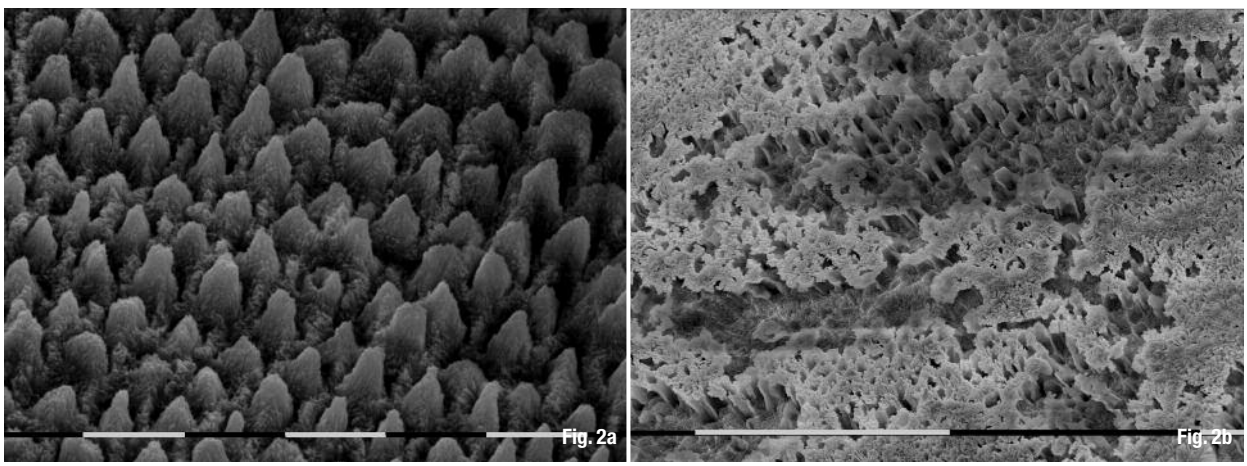


Fig. 2_Type 2 etching pattern in normal enamel: prism peripheries are preferentially removed **(a)**. Acid etching of hypoplastic enamel showed a patchy loss of surface tooth structure without evidence of etching patterns **(b)**.

_Aim

This in vitro study compares the etching effects of acid etchant and Er:YAG laser on hypoplastic enamel (HE) and normal enamel (NE) of extracted human teeth.

_Material and methods

Teeth extracted due to advanced periodontal diseases were collected by patients. All the HE patients had been previously diagnosed by G. Tomov and G. Nikolova using clinical and radiographic criteria.[1]

Clinically, all HE teeth have showed many round, pin head-sized pits, which were concentrated mainly on the buccal and lingual surfaces. The teeth had been kept in saline until the time of study. The buccal surface of each tooth (10 HE and 10 NE, all frontal teeth) was divided and the right side was treated with 37 % phosphoric acid for 60 sec. while the left side was irradiated by Er:YAG radiation (LiteTouch 200 mJ/35 Hz for 10 sec., Figs. 1 a and b). The treated surfaces were evaluated using a scanning electron microscope (SEM), Phillips 505 scanning electron microscope (Phillips Electronic Eindhoven, Netherlands). For SEM analysis, the samples were fixed (2.5 % glutaraldheyde, 12 h, 4°C), dehydrated (25-100 % ethanol), dried, and sputter-coated with gold and examined under different magnifications. The observed changes were photographed and analysed.

_Results

Normal enamel (NE) after acid etching

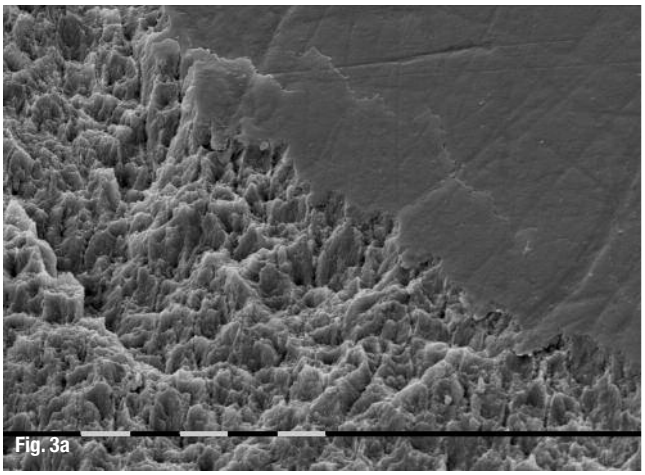
After treatment with 37 % phosphoric acid for 60 sec., the etched area generally showed a type 1 pattern with the prism cores preferentially removed. However, in small, isolated areas, the etching pattern was similar to that of type 2, i.e., prism peripheries were preferentially removed (Fig. 2a). A type 3 etching pattern (general removal of tooth structure without exposing prism structure) was also observed in other isolated areas.

Hypoplastic enamel (HE) after acid etching

The acid etched HE do not exhibit the typical etching pattern seen in control enamel. In the areas where intact surface enamel was presented (without pits), 37 % phosphoric acid etching for 60 sec leads to irregular and patchy loss of surface tooth structure without evidence of uniform etching patterns (Fig. 2b). After etching, no uniform removal of hypoplastic (and hypomineralised) enamel is evident.

Normal enamel (NE) and hypoplastic enamel (HE) after laser conditioning

A comparison of the laser-treated surfaces showed that laser radiation caused a uniform roughness of the enamel for both HE and NE teeth. The morphology patterns were similar without melted or damaged surfaces (Figs. 3a and b).



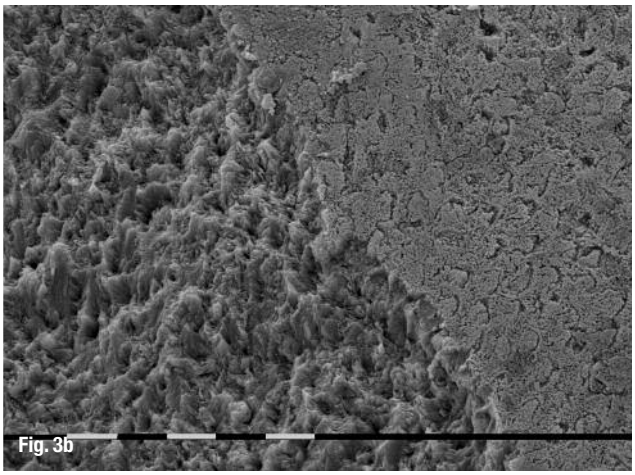


Fig. 3_The laser-treated surfaces showed that laser radiation caused a desired and uniform roughness of the enamel for both HE **(a)** and NE **(b)** teeth.

_Discussion

As the failure rates of adhesive restorations in HE teeth may be high, the question often arises as to whether this type of dental enamel may be successfully etched.[3] The present study addresses this important clinical issue in one clinical variant of Amelogenesis imperfecta, namely, pitted hypoplastic type, using extracted permanent teeth. The common features of normal enamel, as well as the abnormal HE, have been described in previous publications.[4-6] However, there have been no previous studies comparing the effects of acid etching and Er:YAG laser conditioning on hypoplastic enamel. Our study shows that the three classical acid-etching patterns found in normal enamel cannot be reproduced in the HE type. In the case of the pitted hypoplastic variant, the etching pattern was similar to that of type 1, in which the prism cores were preferentially removed. The pattern of prism dissolution was irregular and did not appear to be related to prism structure. Additionally, it is also likely that, because of smaller or weaker prisms, the length of time of the acid etch or the concentration of etchant may not be optimal to produce the classical etch patterns. These hypotheses are based on findings of previous studies which found abnormalities of prism structure, as well as reduction in enamel thickness by more than half compared to normal enamel.6 The acid etching of a less organised hypoplastic enamel structure may result in a pattern that is not the classic etched pattern, which may have a detrimental effect on bonding between the adhesive materials and the affected enamel.

The Er:YAG laser etching seems to be an alternative approach for adhesive treatment of hypoplastic enamel defects. LiteTouch Er:YAG laser used in this study (Syneron, Israel) emits a beam with a 2,940 nm wavelength which is absorbed mostly by water. The mechanism of ablation is based on interaction between laser energy and hydroxyapatite incorporated water which results in microexplosions. It is believed that this process is the mechanism of ablating particles from dental tissues without overheating and without smear layer formation. The program "hard tissue mode" removes enamel, dentin and dental caries effectively and without visible carbonisation or disturbance of the dental microstructure. Evaluated under SEM, the dental tissues treated with LiteTouch Er: YAG laser showed rough and irregular surface without presence of smear layer.[7] Treated enamel shows preserved prismatic structure, but also strong retentions.[7] These results suggested Er:YAG lasers to be effective in the treatment of hypoplastic enamel in order to avoid acid etching. From a clinical point of view, the presence of typical and uniform morphological changes after Er:YAG laser treatment in both normal and hypoplastic enamel suggests that bonding of composite resins may be feasible in most patients with HE. However, the possible advantages of Er:YAG laser conditioning of HE needs further clinical investigation to be approved.

_Conclusions

1. In the pitted hypoplastic type of EH, classical etching patterns after treatment with 37% phosphoric acid like those seen in normal enamel, are generally not observed.
2. Er:YAG laser conditioning produces similar morphological changes in both normal and hypoplastic enamel.

Editorial note: A list of references is available from the publisher.

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