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Safety of Interproximal Enamel Reduction:

a Further Confirmation

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Abstract:

Objective of the study
The objective of this study is to illustrate: a method of SEM digital image processing able to quantify and discriminate between the morphological characteristics of reduced enamel surfaces, when compared with non treated enamel, by treatment with the stripping and finishing technique that proved to be the best in a previous study.

Introduction

A great deal of clinical evidence and reported data in the literature suggest that the burs used to reduce interproximal enamel create furrows and scratches, that can lead to carious lesions, periodontal disease and oversensitivity to extreme temperature.[1] Studies conduced on fragments of intraoral enamel have shown that the size and particularly the depth of these furrows can have a significant effect on remineralization and thus on the formation of demineralizing lesions.[2]
The more numerous and deep the lesions, the higher the risk that they will be carious.
The objective of this study is to illustrate a method of SEM digital image processing able to quantify and discriminate between the morphological characteristics of reduced enamel surfaces, when compared with non treated enamel, by treatment with the stripping and finishing technique that proved to be the best in a previously study. [3]

A case report is included to illustrate the efficiency of interproximal enamel reduction (IER) in improving anterior dental fit.

Matherials and Methods

Ten subjects (mean age 13± 1 years) with Class II division 1 malocclusion were treated with upper second molars extraction and enamel reduction on lower incisors.

To illustrate a method of SEM digital image processing able to quantify and discriminate between the morphological characteristics of reduced enamel surfaces the study group consisted of the healthy exctracted molars (N=20). No teeth with white spots caries or changes in morphology and structure of interproximal enamel were selected for this study.

IER was perfomed on distal surface of the selected molars; the mesial surface was used as control group .The sample were divided into three groups:

-Group A: Non treated enamel;

-Group B: Stripping with No. H135 tungsten carbide bur*;

- Group C: Stripping with No.H135 tungsten carbide bur*and finishing with 20 polish using Sof Lex medium, fine and ultrafine discs **.

To ensure comparability of results, all treatments were performed by a mechanical device that applied an even pressure and removed the same thickness of enamel from each sample.

The surface characteristics on “non treated enamel”, group A, and the degree of roughness and the characteristics of furrows created by the bur and discs on “treated samples”, group B-C, were analyzed on Scanning Electron Microscope*** images.

Two digitally processed algorithms were used for objective analysis of the samples: the roughness index (IR), to measure surface roughness, and the Hough’s Transform, to identify linear structures with the linear structure index (LSI).

Roberts Filters were applied to areas of the SEM images for further clarification of linear structures.

Results

Group A: non treated enamel; enamel surface is not completely smooth. Small number of furrows and irregularity with variable size and depth are distribuited over the entire surface with rounded rims and intersepsed with smooth areas (Fig. 1).

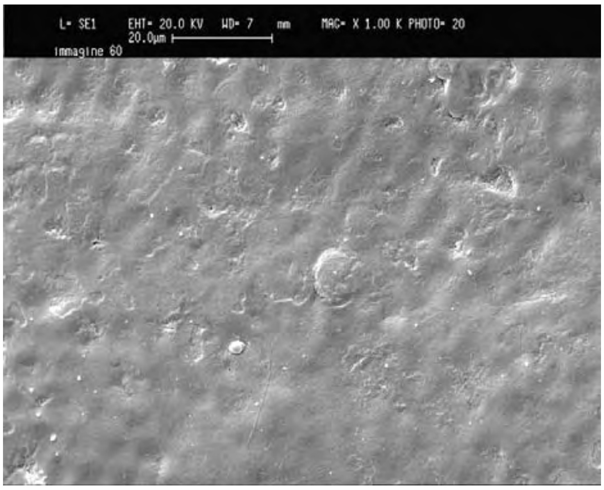


Fig.1. SEM image (X1000), from Group A (non treated enamel), showing a small number of furrows and irregularity.

Group B: The No H135 tungsten carbide bur* creates furrows that were distributed irregularly over the entire surface and interspersed with considerably rough areas (Fig.2).

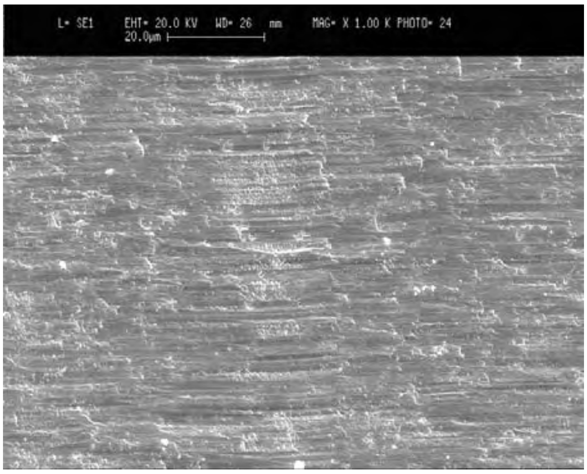


Fig. 2. SEM image (X 1000), from Group B (samples stripped with H135 tungsten carbide bur), showing furrows distributed irregularly over the entire surface and interspersed with notably rough areas.

Group C: The polishings discs** were reasonably effective in smoothing out the irregular furrows left by the stripping bur (Fig.3).

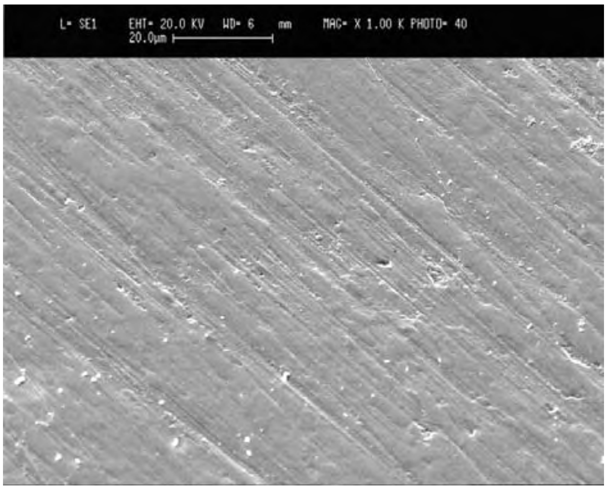


Fig.3. SEM image (X 1000), from Group C (samples stripped with H135 tungsten carbide bur and finished with Sof Lex medium-fine-ultrafine disks), showing smoothing of irregular furrows left by the first bur.

For each image of a tooth subjected to enamel stripping and enamel stripping and finishing, standard local deviation measured surface roughness with the surface roughness index (SRI) and Hough's theorem identified linear structures with the linear structure index (LSI).

In fig. 4, Roberts' Filtre is applied to a subimage from Fig. 3 (Group C). The light area indicates the high contrast pixels. No linear structures are apparent. The angular diagram (Fig.5) of Hough's theorem shows no peaks and LSI values are very similar for all angles.

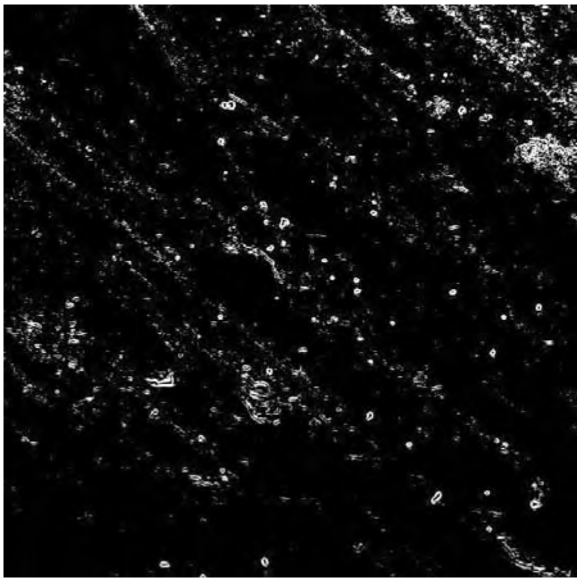


Fig. 4. Roberts Filters applied to subimage from Fig.3 (group C). The light area indicates the high contrast pixels. No linear structures are apparent.

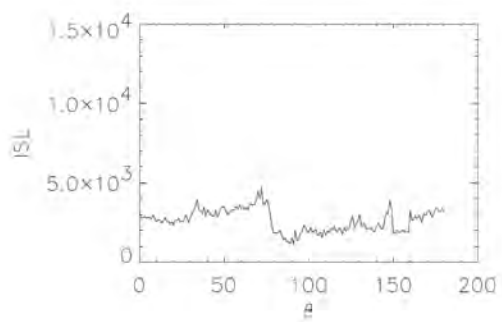


Fig. 5. Angular Diagram of Hough Transform applied to fig. 3 (Group C) shows no peaks and LSI values are very similar for all angles.

RI and LSI values were measured for each sample and the mean and standard deviation were calculated for each group.
The results show on Group C ISL and IR values are 2.22±1.7 and 9.56±1.6, respectively, which show very similar values to non treated enamel (ISL=1.2±0.2, IR=6.06±1.1) (Table I).

	GROUP A		GROUP B		GROUP C	
	Mean	SD	Mean	SD	Mean	SD
ISL	1.2	±0.2	3.32	±1.7	2.22	±1.7
IR	6.06	±1.1	24.29	±1.8	9.56	±1.6

Table I - ISL and IR values.

Case Report

A 13.11 years old female presented with a Class II Division 1 malocclusion.
Facially, the patient appeared symmetrical, with normal lip competence, with a slightly concave profile and a retruded chin (Fig. 6).

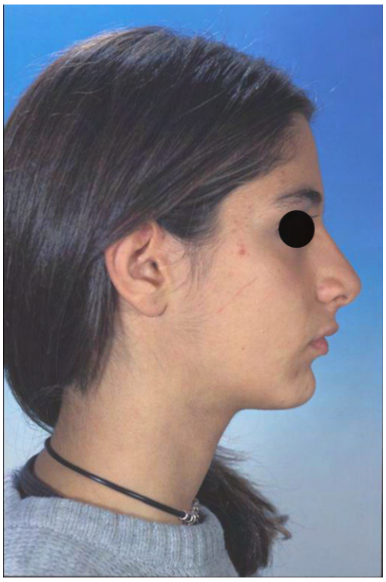


Fig. 6 a, b Preatment facial photographs.

Pretreatment intraoral examination showed a molar relationship half unit Class II on the right side and full unit Class II on the left side, an increased overjet, a deviated dental midline and minimal crowding in both arches (Fig. 7).

Fig. 7 a, b,c,d,e Pretreatment intraoral photographs.

The panoramic x-ray showed a normally developed dentition and the presence of developing third molars.(Fig.8).

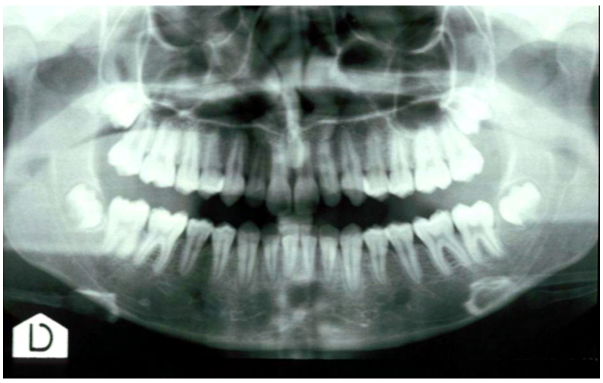


Fig. 8. Pretreatment panoramic x-ray.

Cephalometric analysis showed a skeletal Class II malocclusion due to a retrognathic mandible (ANB=+5°, Ao/Bo=+6mm) and a low angle pattern as indicated by the excessively deep mandibular plane angle (MM=15.9°, FMA=10.2°). The patient also exhibited protruded maxillary incisors ($\underline{1}$ to A-Pog =+5.8mm), and slightly and crowded lower incisors ($\overline{1}$ to Mand Plane =95.1°) (Fig. 9).

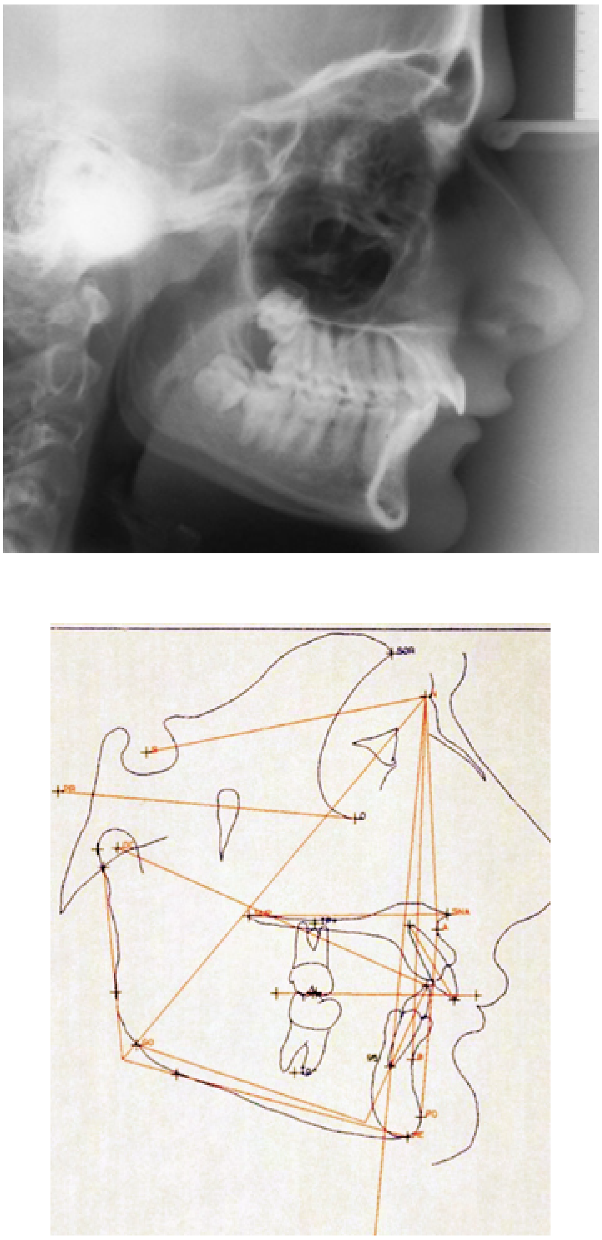


Fig. 9. a- Pretreatment cephalometricx-ray,

b-Pretreatment cephalometric tracing.

Treatment Objectives

The treatment objective included reduction of the protrusion of the maxillary incisors, alignment and uprighting of the mandibular incisors, establishment of a Class I mutually protected occlusion with normal overjet and overbite, alignment of the midlines and improvement of function and aesthetics.

The facial objective was to achieve a more orthognatic profile.

It was decided to extract the upper second molars to achieve a stable distalisation of the first molars, necessary to correct the proinclination and the slight crowding of the upper incisors. Stripping of the lower incisors was decided to correct the crowding in the lower arch without incisor proinclination.

Treatment Progress

Treatment started in March 1999:

second molars were extracted, the upper first molars were banded and all the other teeth were bonded, included first and second lower molars; the appliance was a .022 slot preadjusted, MBT™ prescription****.[4-6] The patient was given a combi headgear to be worn 12 hours a day. Additionally an anterior removable bite plane was placed to assist bite opening.(Fig.10).

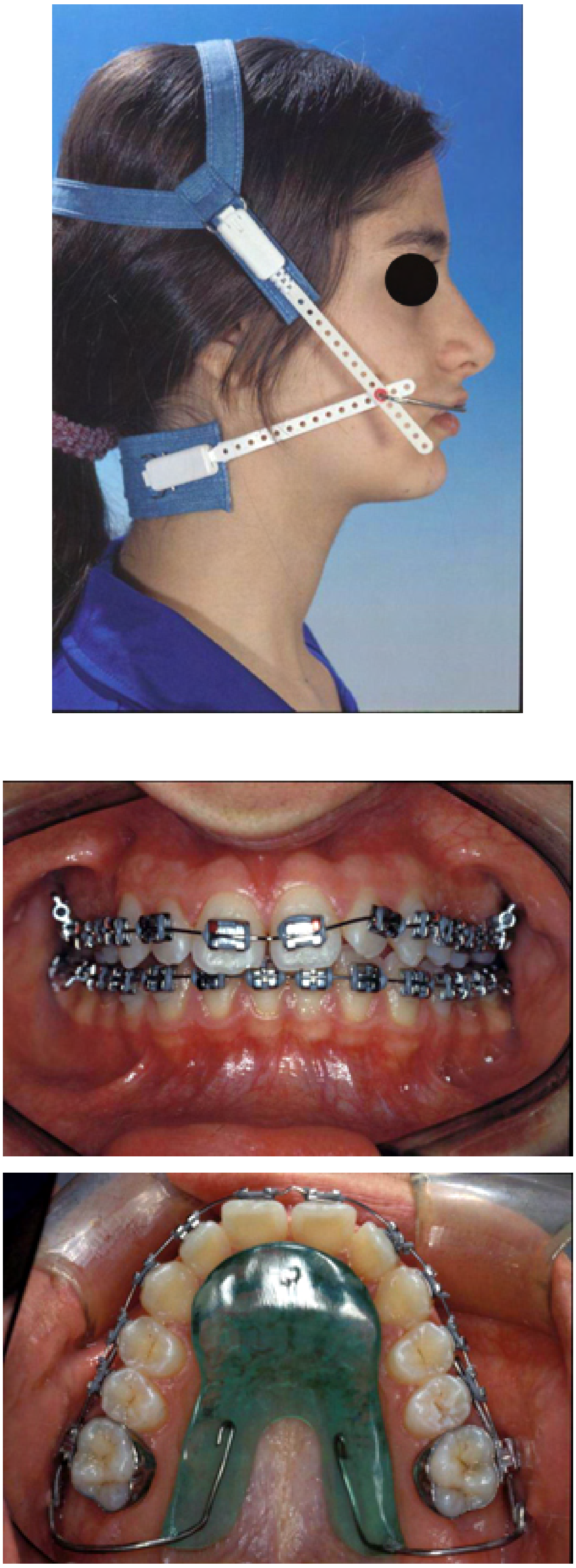


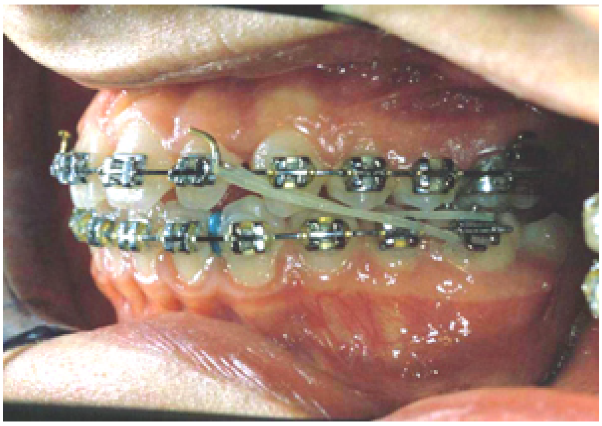
Fig. 10. a-Combi pull headgear, b-initial arch wire, c-application of an anterior bite plane.

The opening wires were .016 Heat Activated Nickel Titanium (HANT).

After 3 months, with an intermediate wire reactivation appointment, the wires were changed to .019×.025 HANT.

After other 3 months with intermediate reactivation .019×.025 SS wires with soldered hooks between lateral incisors and canines were placed. At this point the bite plane was dismissed and the headgear reduced to night time wear.

After one other month day time class II elastics were prescribed (Fig. 11). The patient cooperated very well. In other 2 months the class II was completely corrected, even slightly over corrected, so the headgear was totally dismissed and class II elastics worn only at night.



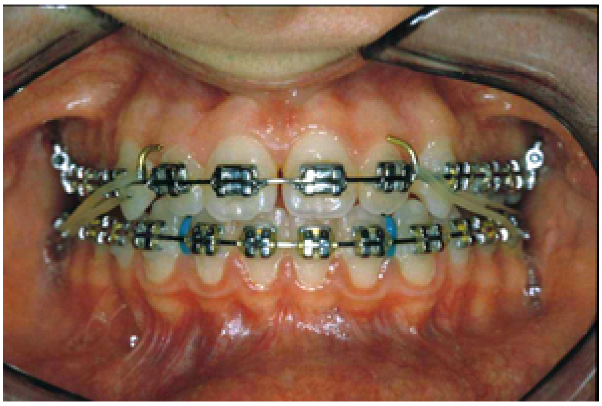
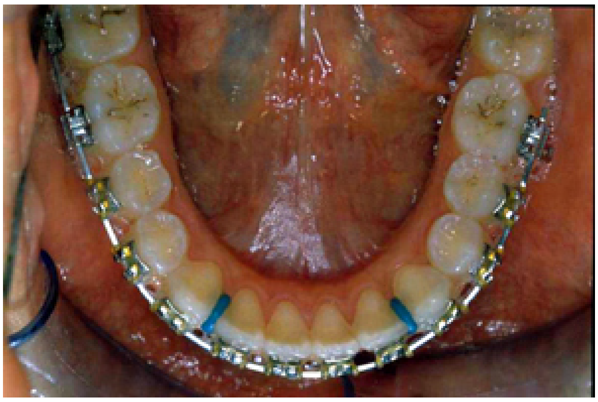
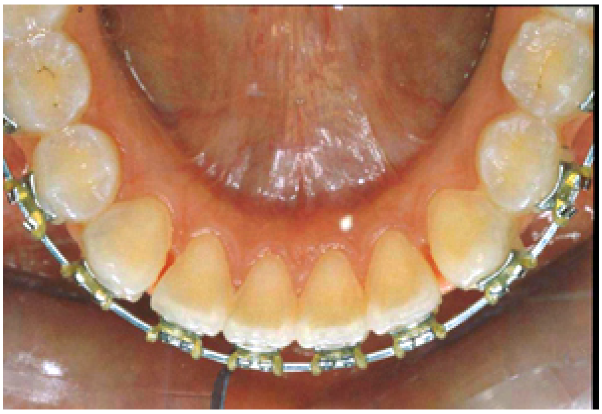


Fig. 11 a,b,c. Application of Class II elastic on rectangular posted archwires.

At this point it became necessary to perform interproximal enamel reduction of the lower incisors to improve anterior dental fit.

Separators were placed initially between lower canines and lateral incisors; after a few days separation had occurred and the distal margins of the lateral incisors were “stripped”. Separators were then placed between lateral and central lower incisors, and after a few days the mesial margins of the lateral incisors and the distal margins of the lower central incisors were stripped (Fig.12).





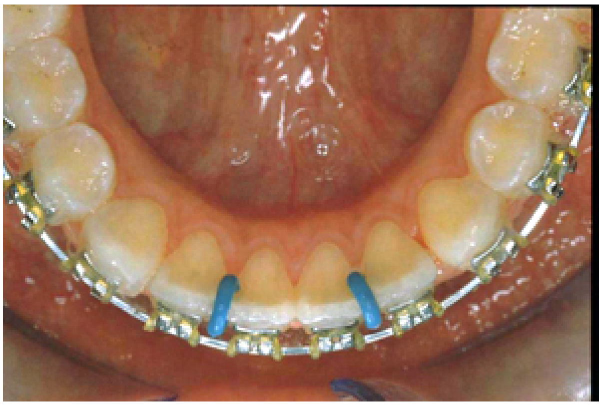
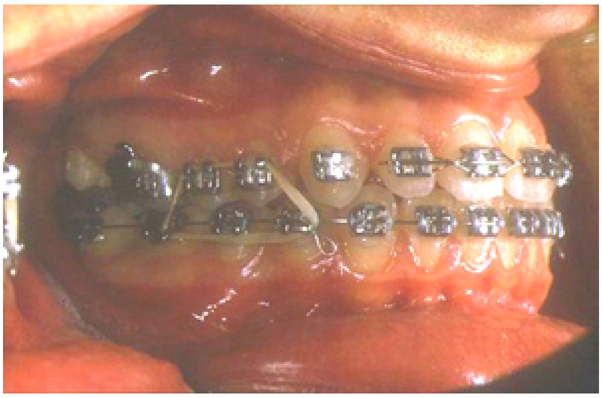


Fig. 12 a,b,c.

Interproximal enamel reduction of lower incisors.

An elastomeric chain was placed between the lower incisors to close the space that was created between them and a tie-back was placed between the soldered hooks on the wire and the hook on the tube of the lower second molars, to close the space between canines and lateral incisors, thus uprighting the lower incisors for a better anterior dental fit.

The case was then finished with light vertical elastics on light wires in the buccal segments to improve the intercuspation (Fig. 13). Total treatment time was 18 months. Retention was performed with an upper removable vacuum formed and a lower fixed 3-3.



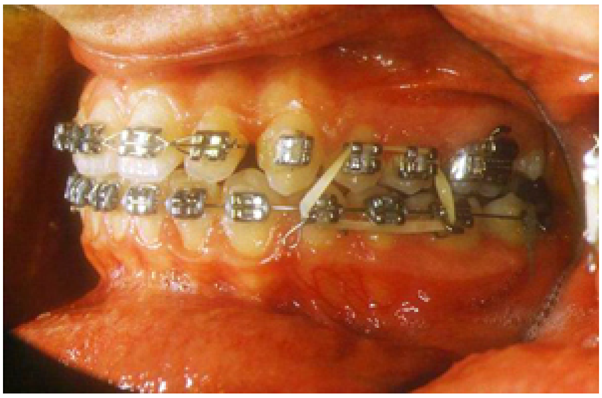


Fig. 13 a,b,c. Finishing stage improving intercuspation.

Treatment results

The overall results were good and facial aesthetics was improved thanks in part to perfect patient cooperation with headgear and intraoral elastics and during the treatment period (Fig. 14). Upper third molars were erupting in a good second molar position.

Post-treatment intraoral examination showed bilateral Class I molar and canine relationship. Both dental midlines were aligned with the facial midline, an ideal overjet and overbite were achieved (Fig.15).

Fig. 14 a,b. Posttreatment facial photographs after 18 months of orthodontic treatment.

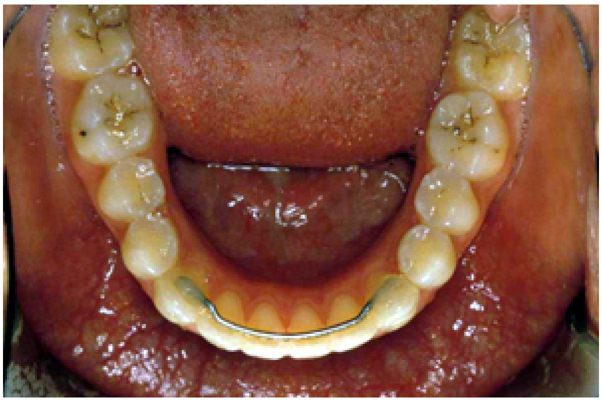


Fig 15 a,b,c,d,e Posttreatment intraoral photographs.

The final panoramic x-ray confirmed the root parallelism and showed good position of the upper third molar erupting in a second molar position (Fig.16).

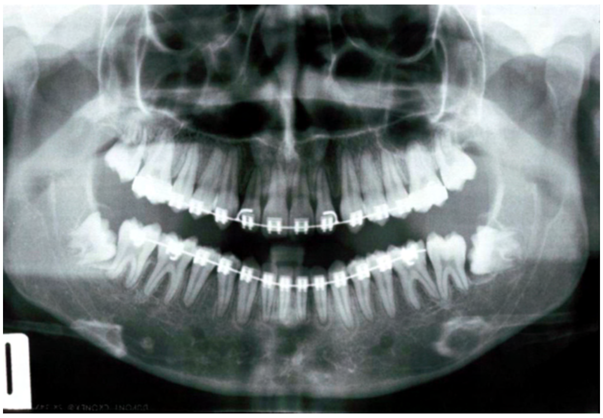
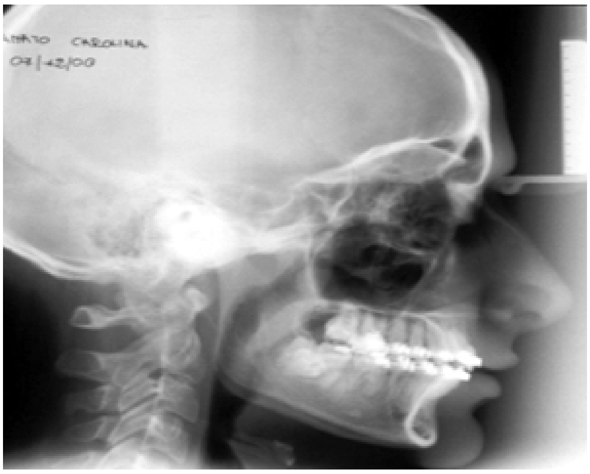


Fig. 16 Posttreatment panoramic x-ray.

Cephalometric analysis and superimpositions confirmed that the most of the correction was obtained by dental change, althought there was some mesial movement of pogonion during the treatment period due to a residual growth (Fig. 17).



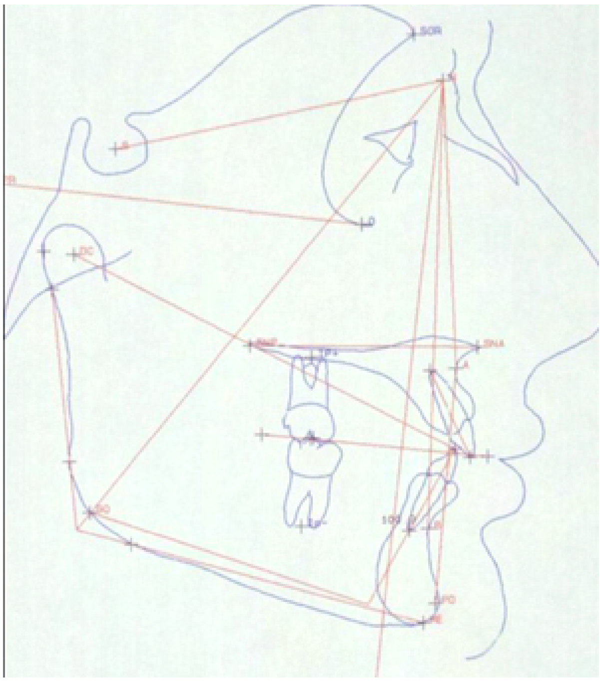


Fig. 17 a-Postreatment cephalometric x-ray, b-Posttreatment cephalometric tracing.

Conclusions

Studies have demonstrated that a reduction in interproximal enamel can increase available space by as much as 6.4 mm when performed solely on the first molars and premolars,[7] by 8.9 mm when the anterior teeth are added,[8,9] and by 9.8 mm when the second molars are added. [10]

Clinicians have found Stripping to be an attractive alternative to transversal and antero-posterior expansion and to extractions.[5,11-15]. A number of other situations may also make stripping mandatory[16-18]: reducing Bolton disharmony to improve occlusion between upper and lower jaw, (stripping front areas to improve overjet-overbite relation, thus improving function); prevention and treatment of interdental gingival recession in association with periodontal treatment in adults; containing and controlling relapse after treatment; redesigning dental morphology for aesthetic purposes; interproximal reduction of mandibular arch when maxillary canines replace missing lateral incisors; interproximal reduction of maxillary teeth in agenesia or extraction of a lower incisor.

In this study, digital analysis of the SEM image showed good results on surfaces polished with medium, fine and ultrafine Sof Lex discs after stripping with a tungsten carbide bur, when compared with non treated enamel.

Concerning the clinical cases, the IER allowed a correct anterior dental fit. No carious lesions, no clinical attachment loss, oversensitivity to extreme temperatures and relapse after treatment was observed on the treated patients.

This work is a further confirmation that IER is a safe procedure, if carried out carefully. It is an important tool to achieve a good anterior dental fit in many cases, treated with sophisticated and efficient modern appliances and treatment techniques.

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