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In vivo enamel stripping: A macroscopic and microscopic analytical study

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Keywords
Interproximal reduction
Stripping protocols
Microscopic study
Surface condition
Dental enamel

Summary

Introduction > Interdental stripping is often used in orthodontics to correct discrepancies of tooth shape or size. However, this procedure involves significant risks for the enamel. The roughness of the enamel surface might depend on the instruments used; it can lead to the accumulation of cariogenic plaque and periodontal problems. The main objective of our study was to evaluate the enamel surface condition after interproximal stripping in the mouth, by comparing different manual and mechanized enamel reduction protocols; on the other hand, the topography of the stripped area was observed to specify its location on the stripped proximal surfaces.
Materials and methods > An *in vivo* study was carried out: interdental stripping was performed in the mouths of patients undergoing orthodontic treatment and on healthy teeth intended for extraction for orthodontic or periodontal reasons. The sample was divided into four groups: in group 1, the distal faces were stripped with conventional single-sided diamond abrasive strips and non-stripped mesial faces (control faces); in group 2: the distal faces were stripped with the manual ContacEZ IRP Kit (single-sided abrasive files of different grain sizes) and non-stripped mesial faces (control faces); in group 3: the faces were stripped with ContacEZ IRP diamond discs attached to a handpiece and the mesial faces were not stripped (control faces); in group 4: the distal faces were stripped with the Intensiv Ortho-Strips mechanized system and the mesial faces were not stripped (control faces).
Results > Our study showed that regardless of the type of stripping material used, the enamel surface showed some roughness with the presence of striations and grooves of different widths and depths. Our observations objectivised more regular and less roughened enamel surface conditions when using the Intensiv oscillating files. Manual instruments (abrasive strips and files) have shown rougher and more irregular surface conditions that may constitute a real risk of carious and periodontal disease. The macroscopic evaluation of the topography of the stripped area showed that there is great variability in the situation and extent of the stripped area in relation to several parameters.
Conclusion > The current mechanized instruments (oscillating files) provide enamel stripping with more comfort for the patient and the practitioner, and seem to produce a more regular and less harmful surface condition for the tooth and periodontium.

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Mots clés
Réduction interproximale
Protocoles de *stripping*
E´tude microscopique
E´tat de surface
E´mail dentaire

Résumé

Stripping in vivo : étude analytique macroscopique et microscopique

Introduction > *Le* stripping *interdentaire est souvent utilisé en orthodontie pour corriger des dysharmonies de forme ou de dimension dentaire. Toutefois, cette procédure entraîne des risques importants, pour l'émail. La rugosité de la surface amélaire dépendrait des instruments utilisés ; elle peut entraîner l'accumulation de la plaque cariogène et des problèmes parodontaux. Notre étude a pour objectif principal d'évaluer l'état de surface amélaire, après réalisation d'un* stripping *interproximal en bouche, en comparant différents protocoles de réduction amélaire manuels et mécanisés ; d'autre part, la topographie de la zone strippée a été observée, pour préciser son emplacement sur les surfaces proximales strippées.*

Matériels et méthodes > *Il s'agit d'une étude in vivo, le* stripping *interdentaire a été réalisé en bouche, chez des patients au cours du traitement orthodontique, et sur des dents saines destinées à être extraites pour des raisons orthodontiques ou parodontales. L'échantillon est réparti selon quatre groupes : dans le groupe 1, les faces distales sont strippées avec des bandes abrasives diamantées classiques unifaces, et faces mésiales non strippées (faces témoins) ; dans le groupe 2 : les faces distales sont strippées avec le Kit manuel ContacEZ IRP (limes abrasives unifaces de granulométrie différente), et faces mésiales non strippées (faces témoins) ; dans le groupe 3 : les faces sont strippées avec les disques diamantés ContacEZ IRP montés sur pièce à main, et faces mésiales non strippées (faces témoins) ; dans le groupe 4 : les faces distales sont strippées avec le système mécanisé Intensiv Ortho-Strips, et les faces mésiales ne sont pas strippées (faces témoins).*

Résultats > *Notre étude a montré qu'indépendamment du type de matériel de* stripping *utilisé, la surface amélaire a montré une certaine rugosité, avec la présence de stries et de rainures de différentes largeurs et profondeurs. Nos observations ont objectivé des états de surfaces amélaires plus réguliers et moins rugueux en utilisant les limes oscillantes Intensiv. Les instruments manuels (bandes et limes abrasives) ont montré des états de surface plus rugueux et plus irréguliers susceptibles de constituer un réel risque carieux et parodontal. L'évaluation macroscopique de la topographie de la zone strippée a montré qu'il existe une grande variabilité dans la situation et l'étendue de la zone strippée en rapport avec plusieurs paramètres.*

Conclusion > *Les instruments mécanisés actuels (limes oscillantes) assurent un* stripping *amélaire avec plus de confort pour le patient et le praticien, et semblent produire un état de surface plus régulier et moins néfaste pour la dent et le parodonte.*

Introduction

The therapeutic solution in orthodontics generally results from the decision to extract or not to extract teeth for the dental alignment and labio-version incisors correction. The boundary between these two limits is poorly defined by practitioners and has been the subject of ongoing debates between extractionist and non-extractionist orthodontists ever since the beginning of orthodontics. This has led to recognition of therapeutic concepts, which are less extractionist, even for cases with significant dental crowding [1,2]. One of the old concepts which is making a comeback is the stripping. It corresponds to the reduction in the mesiodistal diameter of the proximal dental surfaces in order to gain space on the dental arch [3–6]. This remodelling is carried out by orthodontists after a precise and quantified evaluation of the maximum quantity of enamel that needs to be removed according to a rigorous protocol, with specific instruments, and without anaesthesia because it is a totally painless procedure [7–11]. Nevertheless, the removal of a part of the enamel leaves a rough surface that promotes bacterial adhesion, which is very significantly correlated with dental caries [12–15].

The main objective of our study was to evaluate the condition of the enamel surface after interproximal stripping in the mouth by comparing different manual and mechanized enamel reduction protocols; on the other hand, the topography of the stripped area was observed to specify its location on the stripped proximal surfaces.

An *in vivo* study was carried out; interdental stripping was performed in the mouths of patients undergoing orthodontic

treatment, on healthy teeth intended for extraction for orthodontic or periodontal reasons.

Materials and methods

Materials

Sample

Our sample was composed of patients who were undergoing orthodontic treatment in the dentofacial orthopaedic department of the Rabat Consultation and Dental Treatment Centre (CCTD), and who were randomly selected according to the following inclusion and exclusion criteria.

- Inclusion criteria:
  - Healthy and intact teeth,
  - Teeth extracted for orthodontic or periodontal reasons.
- Exclusion criteria:
  - Presence of cavities, restorations, fractures, cracks, abrasions, fluoridation.

The selected teeth were divided into 4 groups distributed as follows:

- Group 1: the distal surfaces were stripped with standard single-sided diamond abrasive strips, and the mesial surfaces were not stripped (control surfaces).
- Group 2: the distal surfaces were stripped with the manual ContacEZ IRP Kit (uniform abrasive files of different granulometry), and the mesial surfaces were not stripped (control surfaces).
- Group 3: the distal surfaces were stripped with ContacEZ IRP diamond discs attached to a handpiece, and the mesial surfaces were not stripped (control surfaces).
- Group 4: the distal surfaces were stripped with the Intensiv Ortho-Strips mechanized system, and the mesial surfaces were not stripped (control surfaces).

For this preliminary study, 16 teeth were selected: 4 teeth per stripping protocol (4 stripped surfaces and 4 control surfaces).

Stripping systems used

For this study we tested different means of interdental stripping.

- The Intensiv Ortho Strips system (INTENSIV®-swiss dental product). This is a new, mechanized system which is composed of a special contra-angle handpiece with axial oscillation (Ref WG 69-LT) and diamond files of decreasing granulometry (Ref OS90, OS40, OS15).
- ContacEZ IPR files (Ortho classic®: yellow 0.06 mm, Ref 701.0002; red 0.12 mm, Ref 701.0003; blue 0.15 mm, Ref 701.0004; green 0.20 mm, Ref 701.0005). This manual system uses flexible diamond strip segments attached to coloured plastic frames. These strips bend and conform to the proximal contours of the teeth. This system provides optimal tactile control and protection for lips and cheeks.
- The sequence of use: the sequence is IPR yellow 0.06 mm, IPR red 0.12 mm, IPR blue 0.15 mm, and finally IPR green 0.20 mm.
- ContacEZ IPR (Ortho classic®) diamond discs. This set of diamond discs consists of a single-sided disc with a working inner face for distal face reduction (Ref 7001.0013/0.10 mm), a double-sided disc (Ref 701.0015/0.10 mm) and a perforated double-sided working disc (Ref 701.0017/0.15 mm).
  The sequence is initiated by the double-sided diamond disc (Disc B), then the perforated disc (Disc D) and lastly, the passage of the single-sided disc (Disc B);
- Classic single-sided diamond abrasive strips 3M™ ESPE SOFLEX™ (Ref 2540).
  They are 0.15 mm thick and are used manually with a back and forth movement in the interproximal space.

Methods

Clinical stripping protocol

Before starting the stripping procedure, a wooden wedge was put in the interproximal space to protect the interdental papilla. Stripping was performed by the same operator who respected the recommendations given by the supplier for each system.
After being stripped in the mouth, the teeth were extracted on the same day, thoroughly cleaned, disinfected with a diluted sodium hypochlorite solution and stored in saline. Before the microscopic analysis phase using a scanning electron microscope, the teeth were immersed in ethanol for 24 hours and dried with a normal hair dryer.

Macroscopic and microscopic analyses

Macroscopic observation of the stripped proximal surface was performed with a magnifying glass and the image was photographed with a digital camera to evaluate the topography of the stripped surface (centred or off-centre situation).
The microscopic analysis was carried out using a scanning electron microscope at the Moroccan Foundation for Advanced Science, Innovation and Research (MAScIR) to assess the condition of the enamel surface after stripping.

Results

Macroscopic analysis of the prepared surfaces

In our present study, the macroscopic evaluation of the topography of the stripped area showed that there is great variability in the situation and extent of the stripped area in relation to the proximal anatomy of the tooth, its rotation and the system used (mechanical or manual). These observations should guide further studies to standardize the clinical stripping procedure.
The comparison of the four methods tested in our study showed that the stripping area was perfectly placed on the stripped teeth for the protocol using the conventional abrasive strip (*figure 1*) and the Intensiv Ortho Strips system (*figure 2*), while it was slightly off-centre for the manual ContacEZ IRP kit (*figure 3*).
For ContacEZ IPR diamond discs, the stripping area was slightly off-centre (*figure 4*). This mechanized system is composed of rigid and non-flexible discs (lack of tactile sensation) and, as a result, the proximal anatomy and axis of the tooth were less respected (*figure 4*).

FIGURE 1
Stripping with a conventional abrasive strip, the stripping area is perfectly positioned

FIGURE 2
Stripping using the Intensiv Ortho Strips system, the stripping area is perfectly positioned

FIGURE 3

Stripping carried out using the manual ContacEZ IRP Kit, the stripping area is slightly off-centre

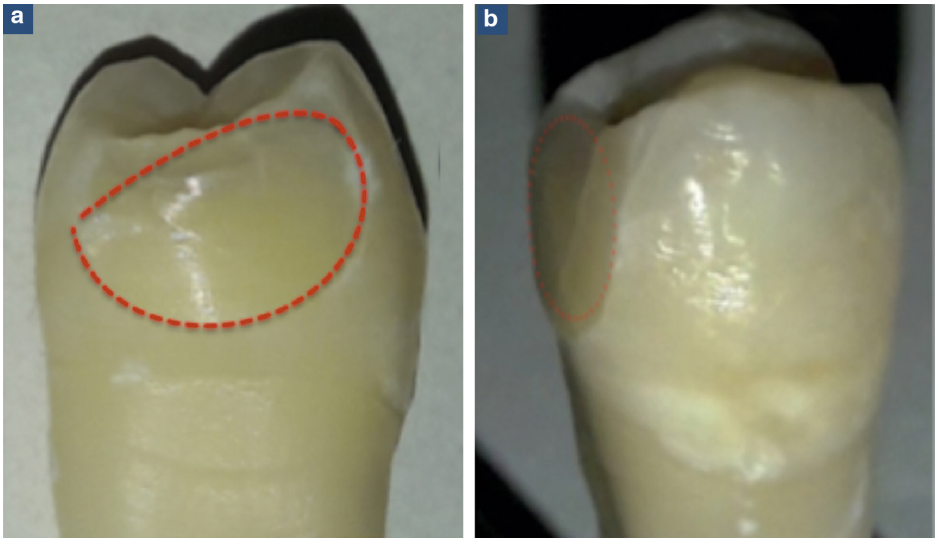

FIGURE 4

a–b: stripping performed with ContacEZ IPR diamond discs; a: the stripping area is slightly off-centre; b: failure to respect the anatomy of the proximal surface, failure to respect the axis of the tooth

Microscopic analysis of prepared surfaces

Microscopic analysis using a scanning electron microscope allowed us to analyse the condition of the enamel surface for the four protocols tested in our study.

The photomicrographs of the enamel surface, relating to the use of the classic single-sided diamond strips (Group 1) showed a very rough and irregular surface, crossed by wide and deep furrows (*figure 5*) which did not follow the same direction. The average width of these furrows was estimated at 15 µm.

The results of Group 2, on the use of ContacEZ diamond files, showed a rough and irregular surface with shallow furrows running through it, which did not follow the same direction. The average width of these furrows was estimated at 10 µm (*figure 6*).

In Group 3, the micrographs of the enamel surface, relating to the use of Contact EZ diamond discs, objectivised a regular and slightly rough surface. The furrows appeared shallower, uniformly distributed over the surface of the enamel and they followed the same direction. The average width of these furrows was estimated at 10 µm (*figure 7*).

In addition, the use of the Intensiv Ortho-Strips system (group 4) produced a regular, uniform surface with a low roughness. The furrows appeared shallower, uniformly distributed over the surface of the enamel and they followed the same direction (*figure 8*).

Discussion

Many publications have addressed the *in vitro* issue, and few have assessed the microscopic aspect *in vivo*. Our *in vivo* study has the originality of comparing 4 stripping methods by microscopic analysis [16–23]. Macroscopic evaluation of the topography of the stripped area showed that there was great variability in the situation and extent of the stripped area in relation to the proximal anatomy of the tooth, its rotation and the system used (mechanical or manual). This should guide further studies to standardize the clinical stripping procedure.

Thanks to SEM photomicrographs, our study showed more regular and less rough enamel surface conditions when using Intensiv oscillating files. The ContacEZ diamond rotary discs have also demonstrated a good surface condition, which is regular but slightly rough. Manual instruments (abrasive strips and files) show rougher and more irregular surface conditions, which may constitute a real risk of carious and periodontal disease. These conclusions reaffirm the results published in various research studies.

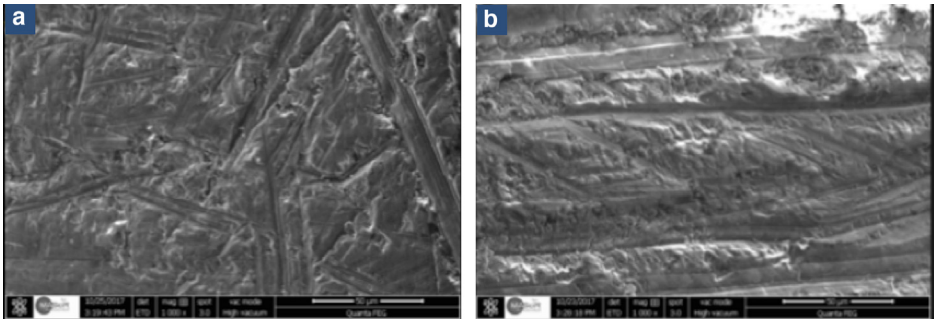

Figure 5

a–b: SEM micrograph of the permanent enamel after stripping with a conventional single-sided abrasive strip (group 1). a: × 1000, distal surface of the 24; b: × 1000, distal surface of the 34

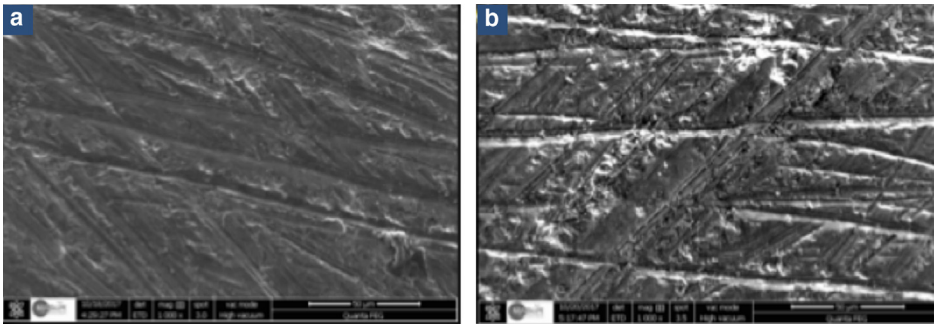

Figure 6

a–b: SEM micrograph of the permanent enamel after stripping with the contact diamond files (group 2). a: × 1000, distal surface of the 34; b: × 1000, distal surface of the 44

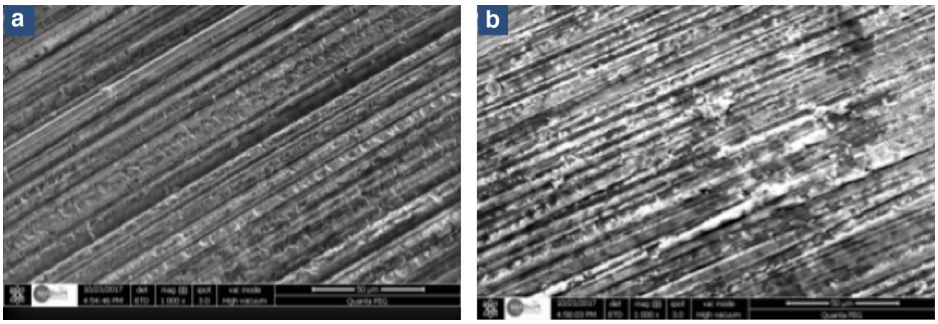

FIGURE 7

a–b: SEM micrograph of the permanent enamel after stripping with a contact diamond disc (group 3). a: × 1000, distal surface of the 34-bis; b: × 1000, distal surface of the 44-bis

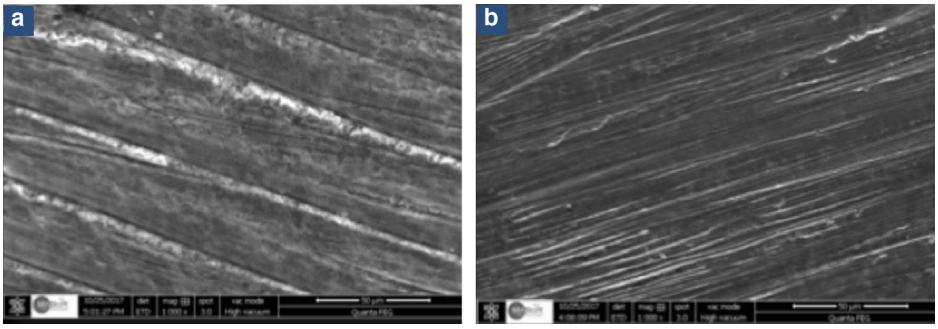

FIGURE 8

a–b: SEM micrograph of the permanent enamel after stripping with the Intensiv Ortho-Strips system (group 4). a: × 1000, distal surface of the 25; b: × 1000, distal surface of the 15

According to the results of our study, diamond abrasive strips have proved to be the most aggressive for enamel, creating wide and deep furrows and grooves that are difficult to reduce even with finishing processes. This fact has been confirmed by several authors, including Radlanski et al. [10]. The latter proved that, even the use of the finest finishing strips, could not eliminate the deep furrows resulting from prior abrasion by a coarse-grained abrasive strip. The remaining furrows, caused by the abrasive procedure, are so deep and wide that plaque accumulation can be expected, creating a predisposition to caries and periodontal disease [10].

Sebastian et al. have shown that stripping and the interproximal reduction method have a significant influence on the enamel surface condition, and that polishing results in smoother surface conditions [24].

The Intensiv system tested in our study, in addition to being a practical system (easy to use, time-saving and comfortable both for the practitioner and the patient), uses oscillating files with decreasing granulometry. In fact, this system makes it possible to ensure polishing and finishing of the surface condition, a possibility confirmed by the study of Danesh et al. [19].

The finishing step was fundamental to minimize the number of abrasions caused by stripping and to obtain a surface condition close to that of an untreated enamel surface [20,24,25].

Topical application of fluoride after interdental stripping has the advantage of making the enamel surface harder and less receptive to tooth decay [22].

Conclusion

Recent mechanized instruments (oscillating discs and files) provide dental stripping with greater comfort for the patient and practitioner and they seem to produce a more regular and less damaging enamel surface condition for the tooth and the periodontium.

The finishing step was fundamental to reduce the number of abrasions caused by stripping and to obtain a surface condition close to that of an untreated enamel surface. It was performed with Sof-Lex™ abrasive discs, which are available in 4 different grain sizes (coarse to super fine) to obtain a shiny finish and polish of the entire interdental surface.

Disclosure of interest: the authors declare that they have no competing interest.

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