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SEM (Scanning Electron Microscope) Evaluation of Surface Roughness after Proximal Stripping of Teeth Followed by Application of Fluoride Varnish and Bonding Agent

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Authors' contributions

This work was carried out in collaboration between all authors. Author NA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors HD, KP and NP managed the analyses of the study. Authors RA and ND managed the literature searches. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: The objective of this SEM study was to compare the surface roughness after proximal stripping with tungsten carbide bur and hand pulled strip then again followed by application of fluoride varnish and bonding agent.
Place and Duration of Study: Department of Orthodontics and Dentofacial Orthopaedics, Manubhai Patel Dental College, Vadodara, between September 2015 and March 2016.
Methodology: 30 healthy human teeth were used which required removal for orthodontic purpose. Teeth were randomly selected and divided into 6 group of 5 each. Group I – stripping with Hand pulled strips(Ortho Organizers), Group II – stripping with tungsten carbide bur (SS White), Group

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III - stripping with single sided hand pulled strips (Ortho Organizers) followed by bonding agent application ,Group IV - stripping with tungsten carbide bur (SS White) followed by bonding agent application ,Group V- stripping with Single sided hand pulled strips(Ortho Organizers) with fluoride varnish application, Group VI - stripping with tungsten carbide bur (SS white) followed by fluoride varnish application.

Results: The SEM investigations demonstrated that small number of furrows were formed in group ii when compared to group i, the bonding agent formed a smooth layer over rough area produced after stripping in group iii and group iv, while a continuous uniform layer of fluoride varnish was formed in group v and group vi.

Conclusion: It can be said that the bonding agent and fluoride varnish form a protective layer, which will make the area less favourable for plaque accumulation or prevent its demineralization from oral acids and thereby reduce the incidence of caries, which is always seen after proximal stripping of teeth. Tungsten carbide bur produces a surface which is smoother when compared to the deep uniform furrows formed with hand pulled proximal strip. So It can be said that proximal stripping with tungsten carbide bur followed by application of fluoride varnish or bonding agent is preferable.

Keywords: Scanning electron microscope; proximal stripping; fluoride varnish; bonding agent.

1. INTRODUCTION

Interproximal enamel reduction is also known as interdental stripping, enamel approximation, or slenderizing. Clinicians have practiced stripping to be an attractive alternative to transverse or antero-posterior expansion and to extractions. Several procedures are used in daily orthodontic practice to perform precise interdental stripping as part of the treatment plan [1].

Stripping of anterior teeth in cases which exhibit mild crowding is increasing in popularity [2]. Some orthodontists also advocate stripping to improve stability or to reshape the morphology of the teeth for aesthetic reasons.

Proximal stripping can be achieved with hand-held or motor-driven abrasive strips and also with disks or burs mounted on a hand piece. Nowadays AIROTOR STRIPPING (ARS) are most commonly used method for reduction of enamel [3-5].

According to Hudson [6], mesiodistal diameter reduction increased the risk of caries by roughening the enamel thus producing a tendency to retain debris. Several reported data suggest that the burs used to reduce interproximal enamel create furrows and scratches that can lead to carious lesions [1]. Danesh et al. [7] concluded that the use of coarse strips or burs for interproximal reduction left irregular surfaces that cannot be smoothed effectively by subsequent polishing. According to study done by Srivastava et al. [8] airrotar striping increases the chance of demineralization and the chance of developing caries increases by many fold. In a study done by Alessandra and Federico [9] they concluded that when human enamel surfaces were stripped and finished under in vitro condition, it was not possible to produce an enamel surface free of furrows when evaluated under scanning electron microscope (SEM). According to Piacentini and Sfondrini [3] tungsten carbide bur produces smoother surface when compared to diamond bur, so we have used tungsten carbide bur in this study.

Rogers and Wagner [10] studied that the enamel treated with a single application of fluoride had a significantly lower rate of decalcification. Sheridan and LeDoux [11] concluded that when Sealant resins were applied to mechanically roughened surfaces, it produces a noticeably smoother surface than the unaltered enamel surface. In a study done by Shah et al. [12] enamel surfaces were rougher after stripping with diamond coated bur compared to surface after stripping with tungsten carbide bur.

Various method such as digital subtraction radiography, profilometry and scanning electron microscopy are available to visualize and compare the surface structures after the treatment. In our study, Scanning electron microscopy was used to visualize grooves and trenches on the surface as it a reliable method used to see surface morphological changes in many published orthodontic literature.

So the Aim of the present study was to determine the change in surface roughness after stripping with single sided hand pulled strip and tungsten

carbide bur and to study the change in surface roughness followed by application of bonding agent or fluoride varnish on stripped surface.

2. MATERIALS AND METHODS

For this In-vitro study 30 permanent extracted human teeth (15 incisors and 15 premolars) requiring orthodontic extraction were used for the study (5 per each group).

2.1 Inclusion Criteria

a) Non-carious permanent teeth
b) Sound undamaged proximal surfaces

2.2 Exclusion Criteria

a) Grossly carious teeth
b) Teeth with enamel hypoplasia
c) Abraded teeth.
d) Teeth with cervical caries.
e) Enamel cracks on the proximal surface
f) Restoration of any surfaces

2.3 Methodology

Caries-free intact human teeth that had been extracted because of periodontal involvement or for orthodontic extraction were included in this study. The soft tissues and the calculus were removed. The teeth were rinsed with water and stored in distilled water [7]. To simulate in situ conditions, the teeth were mounted on a acrylic base creating a contact at interproximal surfaces of 2 teeth placed adjacently (Fig. 1).

Fig. 1. Two premolar mounted in acrylic base

Teeth were randomly selected and divided into 6 group of 5 each based on the method of proximal stripping and the material of application after proximal stripping.

Group I: stripping with single sided Hand pulled strips.
Group II : stripping with tungsten carbide bur .
Group III: stripping with single sided hand pulled strips followed by bonding agent application without etching.
Group IV: stripping with tungsten carbide bur followed by bonding agent application without etching.
Group V: stripping with Single sided hand pulled strips followed by fluoride varnish application.
Group VI: stripping tungsten carbide bur followed by fluoride varnish application.

The interproximal reduction procedures were carried out to achieve comparable amounts of enamel reduction using the different methods with an interproximal enamel reduction of at least 0.25 mm [7].

Stripping was performed with a single side cutting hand pulled strip(medium single sided blade ,manufactured by Ortho organizers) and a 169 L tungsten carbide bur (Shape: Taper, Tip diameter: 0.5 mm, manufactured by SS white) at 4,000-6,000 rpm (Fig. 2). Before and after stripping, the mesio-distal diameter of each tooth was measured with a sliding digital calliper.

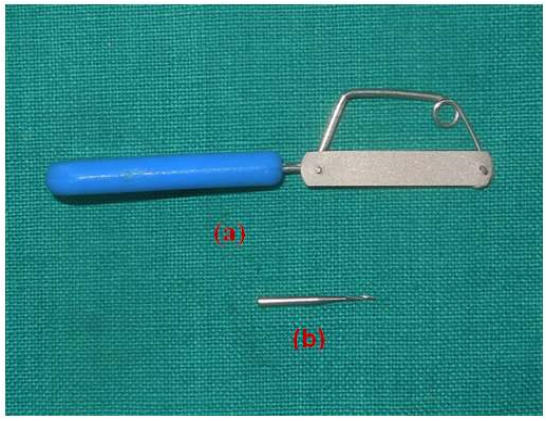

Fig. 2. (a) Single sided hand pulled strip (above); (b) Tungsten carbide bur (below)

After completion of the stripping, application of bonding agent (Transbond™ XT, light cure adhesive, manufactured by 3M Unitek) and fluoride varnish(Slow release topical dental fluoride, 50 mg sodium fluoride, manufactured by Fluoritop SR) was done on the teeth of respective group by the same operator (Fig. 3). The teeth were removed from their supports for further SEM evaluation.

Fig. 3. (a) bonding agent (b) fluoride varnish

Each sample was then mounted on metallic supports. A 20kV scanning electron microscope (JEOL JSM-5610LV) was used at various magnifications (250 x, 550 x and 1000 x) to see the degree of roughness and the characteristics of furrows (Fig. 4).

Fig. 1. Scanning electron microscope (JEOL JSM-5610LV)

3. RESULTS AND DISCUSSION

The images of the proximally stripped surface captured by scanning electron microscope (at 3 magnification showed that:

- The surface after stripping with hand pulled strip (Group I) shows furrows uniformly distributed over the entire surface (Fig. 5).
- Group II which contains surface stripped with tungsten carbide bur shows a small number of furrows interspersed with rough area. Surface is relatively smother compared to those with hand pulled strip (Fig. 6).
- Surface roughness after application of bonding agent in Group III and Group IV were markedly reduced when compared to Group I and Group II respectively. A smooth layer of sealant is formed over the stripped surface
- Proximal surface of Group V and Group VI shows a continuous outer layer of fluoride formed on the stripped surface. The surface roughness is covered with a uniform layer of fluoride

4. DISCUSSION

Enamel reduction with bur or interproximal strip leads to furrows of a size which creates the site for plaque accumulation. So it is necessary to treat the stripped surface. Finishing the stripped surface with polishing strip or bur may smoother, the surface but even the maximum effort to polish interdentally stripped enamel fails to eliminate all furrows [1,13,14].

In the present study SEM images showed deep furrows were formed on the proximal surface stripped with abrasive proximal strip. Similar results were seen in a study done by Joseph et al. [15] in which they concluded that mechanical stripping with coarse abrasive may have advantage of removing the crowding quickly but this produces deep furrows which remains permanently. In our study the SEM images of the surface after stripping with tungsten carbide bur appeared to be smother when compared to that of hand pulled strip. Our findings are also supported by findings of Piacentini et al. [3] who found that tungsten carbide bur allows a very precise first strip and leave a very fine furrow when compared to deep and irregular furrow formed by coarse diamond abrasive. Flouride varnish has been considered as an important material in preventing demineralization. In our study, a layer of fluoride can be seen on the surfaces stripped with bur and hand pulled strip after fluoride varnish application, which forms an outer protective layer. Rogers et al. [10] found that the roughened surface is less resistant to lactate buffer and so a fluoride treatment is inevitable. Topical fluoride application produces a initial reduction in the penetration rate of oral acids by forming a

resistant outer layer [6]. In the present study, when the sealant was applied on proximally stripped surface by bur or hand pulled strip showed marked reduction in the roughness and the surface was remarkably smother when compared to surface without application of sealant, this indicates that sealant application reduces surface roughness and thereby can reduce plaque accumulation and can decrease the risk of dental caries. This findings are similar to those of Sheridan et al. [11] who documented that when bonding agent were applied to proximally grinded surface, the surface roughness was markedly reduced and the sealed surface area were as smooth as the unaltered enamel.

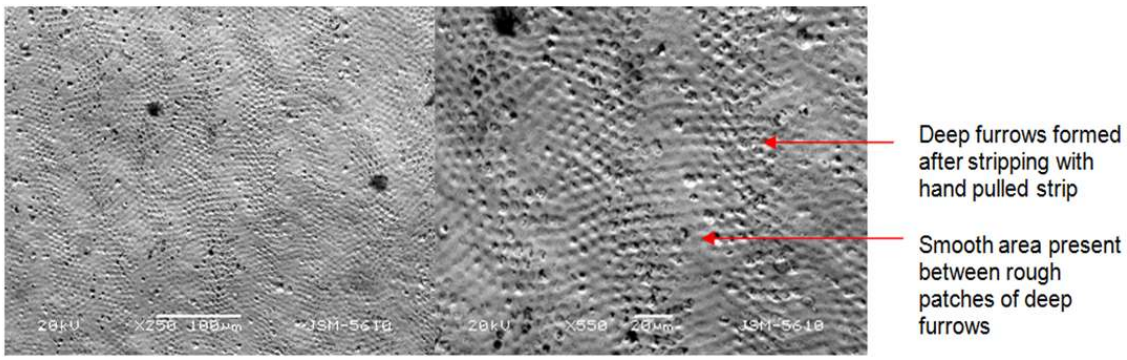

Fig. 5. Group I: SEM micrograph showing deep furrows uniformly distributed.

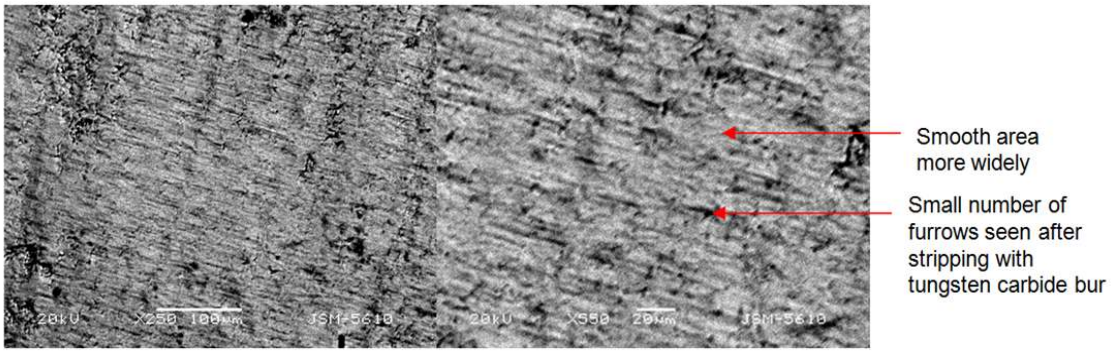

Fig. 6. Group II: SEM micrograph showing small no of furrows interspersed with rough area

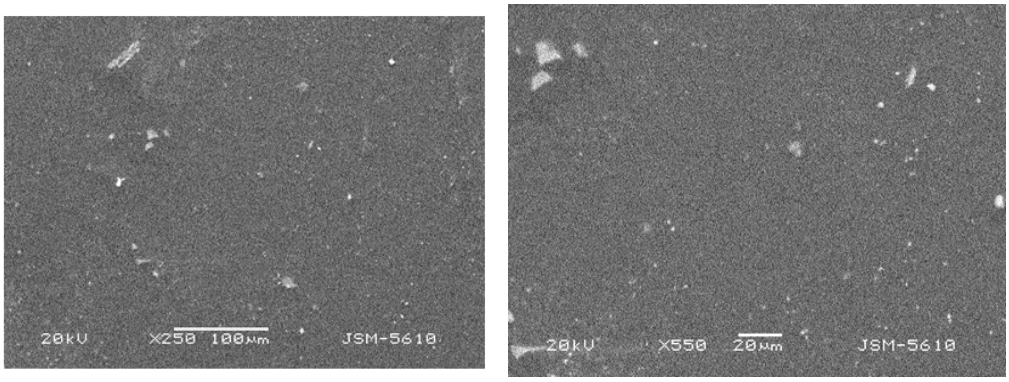

Fig. 7. Group III: SEM micrograph showing a smooth layer formed over the enamel surface

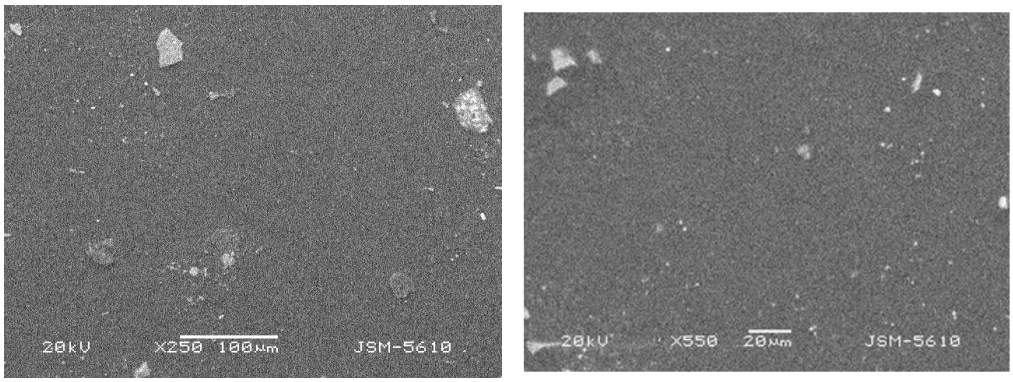

Fig. 8. Group IV: SEM micrograph showing smooth layer formed over the roughened stripped area

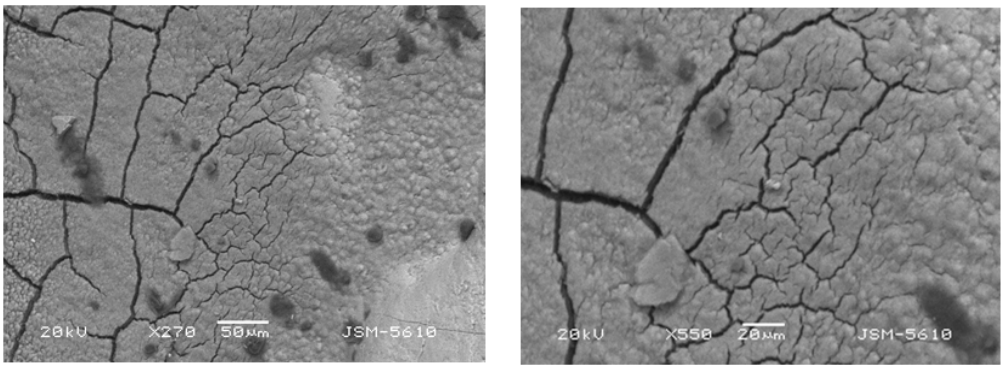

Fig. 9. Group V: SEM micrograph showing a uniform layer formed over the stripped surface

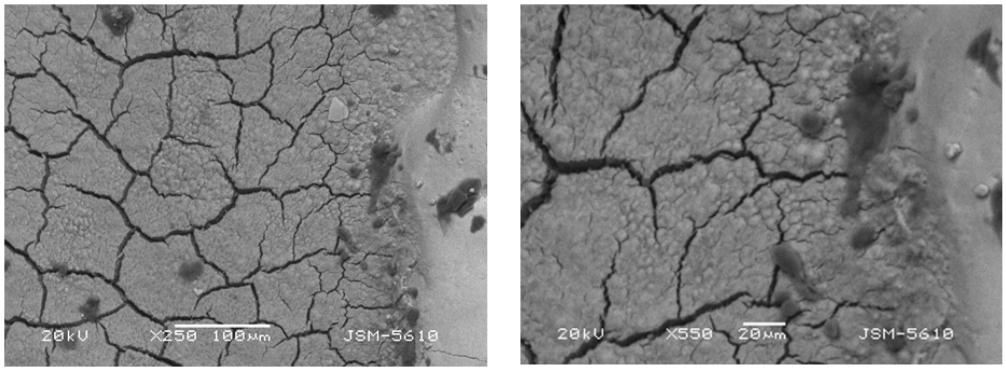

Fig. 10. Group VI: SEM micrograph showing that the stripped surface is covered by a uniform layer of fluoride

5. CONCLUSION

The morphological analysis with scanning electron microscope (SEM) of the surface shows that the results obtained with use of different stripping method are as follow:

- Tungsten carbide bur produces a finely rough surface which is smoother when compared to the deep uniform furrows formed with hand pulled proximal strip.
- A smooth layer is formed after bonding agent application on the rough stripped surface, which acts as a protective coating and makes the area less favourable for plaque accumulation and reduces the incidence of caries.

- A outer uniform layer in formed after fluoride varnish application on the stripped surface which prevents its demineralization from oral acid. Interproximal stripping is a highly useful tool as long as it is done judiciously. so it can be said that proximal stripping with tungsten carbide bur followed by application of fluoride varnish or bonding agent is preferable.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Institutional Ethics Committee (IEC) For Research Manubhai Patel Dental College, Hospital and Oral Research Institute, Vadodara REF. NO.: IEC/ MPDC_068/ORTHO-15/15

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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