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Review

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An Overview on Interproximal Enamel Reduction

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ABSTRACT

Ever since its first introduction seven decades ago, there has been continuous advancement of the concept and technique of Interproximal enamel reduction (IPR). It's demonstrated that with correct case selection and clinical performance, IPR is safe and effective for alleviating crowding, improving dental and gingival aesthetics as well as facilitating post-treatment stability. The fulfilment of treatment outcomes depends on careful pre-treatment examination and planning, appropriate clinical procedures and effective post-treatment protection. This review aims to provide a general introduction to IPR in terms of its history background, risks and benefits and clinical performance.

KEYWORDS: Interproximal enamel reduction; Orthodontic treatment; Crowding; Tooth recontouring

INTRODUCTION

Interproximal enamel reduction (IPR) also described as "stripping", "reproximation" and "slenderizing" has been applied in clinical orthodontics for almost seven decades.[1,2] By removing part of the enamel tissue from the interproximal contact area, this technique has been proved to be effective in improving dental alignment, stability and aesthetics. This review aims to provide an overview on IPR from perspectives of clinical indications, risks and benefits, preclinical evaluation and planning, armamentarium and clinical procedures.

THE BACKGROUND OF IPR

As an adjunctive orthodontic treatment approach, IPR was first introduced in 1944, when Murray L. Ballard reported that it was advisable to strip the interproximal surfaces of lower anterior teeth to address the discrepancy in tooth size.[3] A decade later, Begg found that crowding was absent in Stone Age man's dentition where wearing in occlusal and interproximal surfaces widely presented.[4] Ever since then, there has been a growing interest in the clinical application of IPR. The technique of IPR was for the first time, described in detail by Hudson who applied metallic strips, with subsequent polishing and topical fluoride application.[5] The necessity of IPR was further supported by Bolton in his study on the association between tooth size disharmony and malocclusion.[6] In 1970s, Peck and Peck developed an index indicating the relationship between tooth morphology and dental alignment to facilitate treatment planning.[2] The articles on air-rotor stripping published by Sheridan in the 1980s marked the turning point of IPR technique.[7,8] Later, this technique was also employed in tooth reshaping and black triangle reduction.[9] Owning to its well documented effectiveness in crowding alleviation, stability maintenance and aesthetic improvement, the clinical application of IPR had almost increased by two times between 1986 and 2008 according to a survey conducted in the United States.[10]

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CLINICAL INDICATIONS FOR IPR

There are several indications for IPR in clinical practice. First, it is applied in conjunction with active orthodontic treatment, especially in cases with Class I inter-arch relationship accompanied by Bolton's tooth-size discrepancy and cases with mild to moderate crowding of 3-4 mm.[11,12] Second, it can be used independently to relieve limited crowding and allow self-alignment of the dentition (including the mixed dentition).[12,13] The self-alignment normally takes about 4 to 6 months. Disking primary posterior teeth in conjunction with space maintenance is an effective method to prevent translational crowding and abnormality in the eruption of permanent teeth by utilizing the leeway space and all available arch length. Moreover, IPR is also used to treat black triangle for improvement of aesthetics.[12] After the reshaping of interproximal contour, the contact points of adjacent teeth can be brought apically. Thus, bulbous teeth promises better prognosis because of greater improvement of interproximal contact relationship. Besides, IPR is used for cosmetic re-contouring, most co mmonly in reshaping canines to mimic lateral incisors.[12] Another indication of IPR is for post-treatment prophylaxis in prevention of potential crowding during retention.[13] In cases when relapses have taken place, stripping is advisable to allow realignment without labial tipping of anterior teeth into unstable position.[12]

RISKS AND BENEFITS OF IPR

Whether to adopt IPR in clinical practice is a trade-off situation. On the one hand, IPR can create space for better alignment, minimize potential problems with extraction therapy and yield more stable interproximal contact surfaces, thus allowing 'self-retention'.[12-15] It was found that the teeth of Stone Age man were well-aligned due to the reduction of 12-14 mm arch length throughout life by interproximal wear from abrasive diet. Thus, based on lessons learned from Stone Age man, IPR can be utilized to avoid the unworn and round contacts, which are unstable for tooth alignment with slight interproximal force exerted.[12,13,15]

On the other hand, IPR has its disadvantages that orthodontists should consider with cautions. First, sensitivity may be induced after IPR because of reduced amount of enamel. Second, over-stripping caused by careless pre-treatment planning can lead to excessive space. Furthermore, improper planning may also affect overjet, overbite, posterior intercuspation and aesthetics.[12] It should be borne in mind that anchorage may be sacrificed if stripping is performed posteriorly.[16] The effects of IPR on the risks of caries remain unclear. A number of studies have shown that anterior IPR does not increase the risks of caries and periodontal diseases.[11,17] Mean while, a few studies revealed that posterior IPR increased the risks of caries, which was challenged by other studies.[11,17] However, it is believed that there is more plaque retained because of furrows left on the enamel surface after reduction.[11,17] Regarding the risks of periodontal diseases, it is accepted that without gingival infla mmation, IPR will not cause more bone loss. However, rapid progression of bone loss was evident when infla mmation was present with approximated roots.[11,18] Thus, IPR is contraindicated in patients with poor oral hygiene.

PRECLINICAL EVALUATION OF IPR

Before conduction of IPR, a close examination of the teeth, gingiva and alveolar bone should be carried out. First, there should be no other space available within the dental arch.[13] Second, the patient should have good oral hygiene, especially with no clinical interproximal caries. Third, no previous history of enamel stripping should be presented. Patients with satisfactory periodontal condition showing healthy pink and stippled gingiva, firmly attached gingival papillae with the presence of interproximal col are most suitable for this treatment. In addition, periapical radiographs should also be taken to assess the thickness of enamel, convexity of proximal surfaces, presence of caries, size of fillings and amount of bone between roots.[16]

DETERMINING THE AMOUNT AND SITE OF IPR

It is suggested that IPR be conducted on three occasions: when incisor alignment is achieved, at de-bonding and during retention if necessary.

The amount of IPR should be carefully planned ahead of treatment with the enamel thickness of various tooth positions in mind. Enamel thickness of lower central incisors is 0.77±0.11 mm and 0.72±0.10 mm at distal and mesial surfaces respectively, in comparison with 0.96±0.14 mm and 0.80±0.11 mm respectively for lower lateral incisor.[17] Enamel is thickest at upper canines and distal surfaces of upper central incisors.[19] There is approximately 1 mm of enamel at premolars.[17] Second molars often have thicker enamel than premolars by 0.3-0.4 mm.[11] For all tooth types, distal enamel is normally thicker than mesial enamel.[11] It was found that there was no relationship between tooth size and enamel thickness.[17] Therefore, bigger teeth do not necessarily indicate larger amount of enamel to be reduced. Meanwhile, no relationship can be identified between tooth shape and enamel thickness.[17] Thus, clinical decisions should be cautious when referring to tooth morphology.

It is reco mmended that up to 50% of interproximal enamel can be removed during IPR.[11] The appropriate amount should be 0.5 mm (0.25 mm each side) for each tooth whereas up to 0.75 mm for posterior teeth.[13,17,20] With 50% of enamel reduction per tooth, up to 8.6 mm space can be created by IPR of mandibular teeth.[17] Even if the amount of enamel reduction is the same, space gained from IPR can vary according to the shape of teeth. For instance, more space can be obtained by reducing triangular shaped teeth than rectangular shaped teeth.[17] Amount and site of IPR can be determined by Bolton's ratio in cases of tooth size discrepancy.[8] For instance, if total ratio indicates excessive tooth size of 4 mm with normal anterior ratio in upper arch, enamel reduction should be done in premolar and molar

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regions of upper arch. If total ratio reveals excessive tooth size of 4 mm in upper arch while anterior ratio suggests 2 mm excessive in upper anterior region, reduction should be performed on all upper teeth. The Golden Proportion advocated by Ricketts can also be employed to determine the site and amount of enamel to be reduced.[21,17]

Another guide to IPR for incisors is the Peck Index.[2] This index employs the ratio of mesiodistal to faciolingual dimension (MD/FL ratio) to indicate the alignment of lower incisors. It was found that lower incisors that were naturally well-aligned often demonstrated smaller MD/FL ratio. They suggested that the favourable MD/FL ratio to achieve good alignment of lower incisors should be within 88-92% for central incisors and 90-95% for lateral incisors. However, there has been dispute on the relationship between incisor shape and mal-alignment and relapse.[22,23]

ARMAMENTARIUM OF IPR

There are two types of equipment for IPR: air-rotor and electric-rotor. The former is an air-rotor, contra-angle hand piece with multiplier and can operate at high or low speed (180,000 rpm). It is difficult to change speed when using the air-rotor one. Besides, the torque is inadequate when the low speed is chosen. As with the electric-rotor equipment, speed is adjustable, allowing low speed and high torque at the same time, thus is safer and more accurate.[17] The stripping appliance can be a diamond/meshed disc or a diamond/tungsten carbide bur. A single or double-sided, guarded diamond disc on a mandrel is recommended. It is suggested that discs be placed below contact points before starting the air motor, and then withdrawn to the occlusal direction with water cooling.[24] Other choices include abrasive strips which are suitable for rotated teeth and initial reduction to clear contact points.[12,17] Chemical stripping with phosphoric acid is indicated after mechanical stripping to produce smoother surface and allow re-mineralization.[11,15]

Measurement tools for the amount of enamel removed can be gauges made from round orthodontic wire or metal strips, ranging from 0.2 mm (0.012") to 1 mm (0.040"). Digital caliper can also serve to measure the width of rotated teeth.

CLINICAL PROCEDURES OF IPR

To begin with, rotated teeth should be aligned prior to reduction if possible to arrange the contact points in a more favorable position. It is optional to separate the teeth 3-4 days before IPR.[20,24] Coil spring or separators can be used to open space, improving visual and mechanical access and depressing dental papillae to reduce trauma (with separators). This step is often done when the teeth are too rotated and for reduction to be performed prior to alignment.[20,24] Space opened by coil spring or separator should be measured before reduction to avoid over-stripping. Interdental papillae should be protected with thin brass or steel indicator wire.[20,24]

In the process of IPR, an ultra-fine diamond disc should be placed in the inter-dental space at first followed by reducing mesiodistal widths to the desired dimension.[16] Subsequently, the disc should be inserted below the contact point and swept occlusally.[16] It is suggested that measurement tools be applied to ensure adequate enamel reduction is performed as planned previously. It is also important to ensure that the contact point remains 4.5-5 mm away from the bone crest.[24] If it is too far from bone crest, black triangle may be visible. However, if it is too close, the size of col will become larger, leading to increased periodontalpocket.[24]

After reducing the enamel, it is necessary to contour the tooth to normal shape with appropriate embrasure width suitable for oral hygiene.[16] It is also recommended to restore the contact point since it is brought more apically after reduction.[17] These procedures can be carried out with a bur, an ultra-thin diamond disc or Sof-lex disc. Next, polishing paste should be used to make the surface smoother.[11] Some researchers suggested 35% phosphoric acid in conjunction with fine abrasive strip for better re-contouring.[20,24]

Subsequent to re-contouring, steps should be performed to protect the enamel from increased risks of caries. Various strategies have been suggested, including 8% stannous fluoride for 4 minutes,[13] fluoride mouth rinses for 45 days[19] and 0.05% neutral sodium fluoride mouth rinses once daily.[25] Some researchers also recommended the use of regular professionally-applied fluoride (1.23% acidulated phosphate fluoride) for 4 minutes together with fluoridated dentifrice daily.[26,27] Others suggested casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) tooth mousse for enamel's re-mineralization into subsurface layers.[28] Applying sealant (e.g. fissure sealant) after etching for 20seconds is another approach, yet it may not last long.[16,29]

Chudasama and Sheridan suggested posterior stripping be performed one site at a time from the most posterior site.[20] After enamel was reduced at one site; space should be closed before another stripping on the subsequent visit in order to gain better control and prevent over-stripping. Special attention should be paid to anchorage control at the same time.

CONCLUSION

Interproximal enamel stripping has become an effective orthodontic treatment approach to regain space, improve tooth and gum aesthetics as well as maintain post-treatment stability. Nevertheless, orthodontists should choose appropriate indications by balancing between its benefits and risks. With cautious pre-treatment planning, appropriate performance and post-treatment protection, IPR possesses unique advantages in facilitating better treatment outcome in a more conservative and physiological way without harming dental or periodontal tissue.

However, this article only presented a general overview on IPR. In future, a systematic critical appraisal of existing literature is essential to offer more reliable evidence for research and practice.

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