Interproximal Enamel Reduction: What Clinicians Should Know

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Abstract

Interproximal enamel reduction (IPR) is an orthodontic treatment option for gaining space to correct mild to moderate crowding malocclusions. Presently, there are many IPR instruments and techniques that are available for clinicians. No matter which instruments or techniques of IPR are used, the important thing is that clinicians should be aware of the considerations, advantages, and disadvantages before performing IPR.

Keywords: Interproximal enamel reduction (IPR), Orthodontic treatment, IPR instruments and techniques

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Introduction

Interproximal enamel reduction (IPR) is a clinical procedure of tooth mass reduction and anatomic tooth re-contouring (1). This procedure is also known as air-rotor stripping (ARS), slenderization, or reproximation (2). IPR is an alternative option of the non-extraction orthodontic treatment plan in borderline cases. Recently, this technique has been increasingly used for creating spaces in many orthodontic situations (e.g. gaining space for older patients who have difficulty with extraction space closure or for patients with clear aligner systems).

The background of IPR concepts

The first concept of tooth mass reduction was mentioned by Ballard in 1944. His study illustrated the importance of tooth size harmony and he recommended correcting tooth size disharmony by proximal surface stripping of anterior segments (3). A decade later, Begg presented that old human dentitions with severe interproximal wears had enough spaces for third molars eruption with the dentitions still exhibiting no crowding (4). From this knowledge, many clinicians considered that the interproximal enamel reduction was advised for good orthodontic finishing.

In 1956, the technique of IPR by using metallic strips, first described by Hudson, demonstrated the necessity of polishing after enamel stripping (5). Meanwhile, the importance of tooth size disharmony correction to achieve excellent occlusions was confirmed by Bolton, Peck and Peck (6,7).

In 1985, the air-rotor stripping (ARS) technique was presented by Sheridan that was a crucial development in the orthodontic practices. This space gaining technique was an alternative to extraction or expansion in borderline cases (8). Moreover, Zachrisson recommended proximal stripping to correct triangular interdental spaces of anterior teeth during a finishing phase of the orthodontic treatment (9).

While increased IPR use is supported by the identified benefits, there are several articles presenting the successful options for performing IPR. However, patients occasionally experience unintended negative procedural outcomes. This article highlights the advantages and disadvantages of IPR of which the clinicians should be aware, as well as the factors to be carefully considered prior to performing the IPR and thereby increasing the likelihood of a successful outcome.

The advantages and disadvantages of IPR

IPR procedures can be performed to manage several dental problems (10). The advantages of performing IPR categorized by the fields of orthodontics and esthetics are as follows:

The advantages of IPR in the field of orthodontics

1. Relieve crowding and enable self-alignment correction of dentition by primary posterior teeth stripping (11,12).

2. Gain 3-4 mm of space in cases of mild to moderate crowding, so that the removal of teeth can be avoided (12,13).

3. Adjust the improper tooth size to obtain normal overjet, overbite, and a proper occlusion (Bolton's discrepancy correction) (6).

4. Enhance the stability of the orthodontic treatment results; especially in lower anterior region (14-16).

The advantages of IPR in the field of esthetics

1. Recontour or reshape the individual teeth for esthetic reasons (9,12).

2. Reduce triangular interdental space of anterior teeth and improve their interproximal contact relationship (9).

Besides advantages, IPR procedure, if not properly performed by knowledgeable and skillful clinicians, can cause iatrogenic complications. However, the risk of IPR can be alleviated with the proper treatment plan and attentive treatment.

The disadvantages or risks of IPR

1. Induce tooth sensitivity, especially patients who have hypersensitive teeth.

2. Damage interdental tissue if the procedure is inattentively performed.

3. Can lead to excessive spaces or negatively impact overjet, overbite, posterior teeth intercuspation, and esthetics if the procedure is performed with improper treatment planning (12).

4. Increase plaque retention on the enamel surface (13,17).

5. Create abnormal tooth shape.

Additionally, patients with developmental enamel defects or poor oral hygiene who may present with problems of the tooth sensitivity and susceptibility to caries are contraindications for performing IPR (18,19).

Tooth structure, periodontal tissue and oral hygiene evaluation is necessary for IPR planning. Periapical radiographic image provides useful information, for example, enamel thickness, size of pulp chamber, proximal tooth contour, location of contact points, presence of dental caries, size of old fillings, and the amount of bone between roots (20).

The factors to be considered before performing IPR

Clinicians should carefully consider the following factors while selecting the appropriate armamentarium and technique.

1. Enamel thickness and the amount of enamel to be removed

The study showed that the enamel thickness of posterior teeth became progressively thicker from the first premolar to the second molar. Due to the differential wear pattern of dentition, the thickness of enamel on the distal surface is greater than the mesial surface (21).

Studies recommended different amount of enamel to be safely removed. (Sheridan suggested not to exceed 0.25 mm on each contact of the anterior teeth and 0.4-0.8 mm on each contact of the posterior teeth (22) while Hudson recommended 0.2-0.3 mm per side of lower anterior teeth (5)). It was generally recommended that only half of the proximal enamel thickness can be removed (23,24). However, enamel thickness varies from one tooth to another, and no correlation is found between tooth size and the enamel thickness. Thus, radiographic examination and periapical film should be employed to determine the proper amount.

2. Shape and size of the teeth

Incisor shape can be categorized as rectangular-, triangular-, or barrel-shaped, which presents different contact point shape, contact point location and the different form of interdental space. The contact point of triangular-shaped incisors locates at incisal third of the crowns which creates the triangular interdental space (black triangle) (25). IPR performed in triangular-shaped incisors will not only just obtain space but will also improve the esthetics.

Barrel-shaped incisors tend to have the contact point at the middle and have spaces at the incisal edge, so performing IPR may approximate the incisal edges and relocate the contact point. On the other hand, rectangular-shaped incisors always have a broad contact that are unfavorable for gaining space with IPR. Tooth size should be taken into consideration. Larger teeth are more suitable for IPR whereas smaller teeth, for example, peg lateral incisors are to be avoided (25).

3. Proximal contact area and location

The proximal contact area is the area of proximal height of a tooth that contacts an adjacent tooth in the same arch. Generally, the location of proximal contact is located at the incisal third of anterior teeth, near the junction of the incisal and middle third and at the middle third of posterior teeth (26).

The physiologic proximal contact areas and locations play important roles in maintaining healthy periodontal and interdental tissue and protecting them from possible damage. Improper proximal contact may result in food impaction, potentially increasing the risk of periodontal disease, caries, and tooth movement (26). Thus, it is necessary to properly recontour the tooth into the original shape with the appropriate embrasure and physiologic contact location that enables self-cleansing mechanism (20). The use of an abrasive metal strip is an optimal technique to preserve a tooth shape, although it requires more time (27).

4. Periodontal and intra-oral soft tissues

Stripping the proximal surface of posterior teeth can damage interproximal gingival tissue. A separator or wooden wedge placed between the teeth will allow better access, prevents gingival bleeding, and avoids biologic width damage (23, 28). The rotated teeth should be aligned prior to IPR so that the gingival tissue will not be damaged by stripping (23). IPR with rotary or motor-driven instruments could cause more damage, thus clinicians must use extra care. A tongue and lip protector and a four-handed approach are recommended (28).

Extensive mesio-distal enamel reduction may result in the root proximity that clinicians should concern as a risk of periodontal disease for poor control oral hygiene patients (29). However, there was no signs of periodontal tissue breakdown that were observed between root proximity sites after active orthodontic treatment (30).

Furthermore, clinicians need to pay attention to the relationship between the alveolar bone crest level and the interproximal dental papilla. Generally, the alveolar crest is 1.5 - 2 mm apical to the cemento-enamel junction (CEJ). If the distance from the contact point to the crest of bone is less than 5 mm, interdental papilla will fill up the interdental space approximately 100% (31). However, the triangular interdental space (black triangle) might be present with regard to age of patients, periodontal bone loss, increased distance between the alveolar bone crest to the contact point, improper root angulation, triangular crown and embrasure morphology, or initial position of tooth (32).

5. Enamel roughness and caries risk

Several studies revealed different level of enamel roughness related to the systems and techniques of IPR (17,33-35). Although the enamel surface was properly polished with fine finishing strip, deep furrows caused by coarse abrasive still remained (36). Gupta et al. (2012) recommended tooth polishing with fine Sof-lex discs (3M ESPE, St Paul, MN, USA) to reduce enamel surface roughness (Fig.1) (37).

Fig.1 Sof-lex discs (3M ESPE, St Paul, MN, USA) in contra angle handpiece.

The rough enamel surface of posterior teeth potentially promotes the plaque accumulation and the adherence of bacteria that increase the risk of enamel demineralization (38,39). Thus, it is presumable that IPR may increase the risk of caries (38). However, there is a process of a complex interaction of cariogenic bacteria, food debris and host factors (tooth structure and salivary flow) with time (40). Even though several studies reported that IPR did not result in increased caries risk in anterior teeth (41-43), it was recommended to treat the enamel surface with remineralizing products to reduce the caries susceptibility (44).

6. Effect of fluoride treatment

It is accepted that stripping with manual or rotary instruments leaves scratches and furrows on enamel surfaces (17,27,33,35). Some studies presented that the microhardness of stripped enamel surfaces was decreased and that the irregularities of stripped enamel surfaces resulted in increased demineralization (42,45). Thus, several studies recommended immediate fluoride or remineralizing products application to stripped enamel surfaces to restore the minerals lost during stripping and to preserve the integrity of the enamel surface (8,13,23,44,45). However, Jarjoura et al. (2006) found that immediate fluoride application did not provide any additional benefit for patients who were regularly exposed to fluoridated water and toothpaste containing fluoride (41).

7. Effect of heat on pulp tissue

IPR generates frictional heat which then transferred to the pulp chamber. Pulpal tissue can tolerate intrapulpal temperature increase of 5.5°C. If the transferred heat is higher, the pulp tissue will be damaged (46). Thus, water and air cooling are necessary during IPR (8,9,47).

In vivo and in vitro studies investigated the temperature change in the pulp chamber of different IPR techniques and found that the manual and rotary IPR techniques increased pulpal temperature, however, the increased pulpal

temperature was not in excess of the critical level of 5.5°C (48,49). Therefore, in terms of generated heat, these methods are safe for the pulp tissue.

Armamentarium for IPR

Armamentarium for IPR currently used in the orthodontic practices can be divided into manual and motor-driven or rotary instruments. Because of interproximal access limitation, performing IPR with manual instruments is recommended during initial phase of treatment when crowding has not been alleviated enough. After the teeth are reasonably aligned, it is usually recommended for clinicians to performing IPR with rotary instruments, since clinicians can parallel the instrument to the long axis of the tooth.

Manual instruments

One sided-, double sided- thin metal strips, thickness 0.05 mm, width 6 mm (fig.2a)

Motor-driven or rotary instruments

Diamond disc (fig.2b), Diamond discs with soft tissue protectors (fig.2c and fig.2d), Oscillating discs (fig.2e), High speed airotor diamond burs (fig.2f), Diamond strip motor-driven type (fig.2g), Sof-lex discs (fig.1), IPR gauge set (fig.2h).

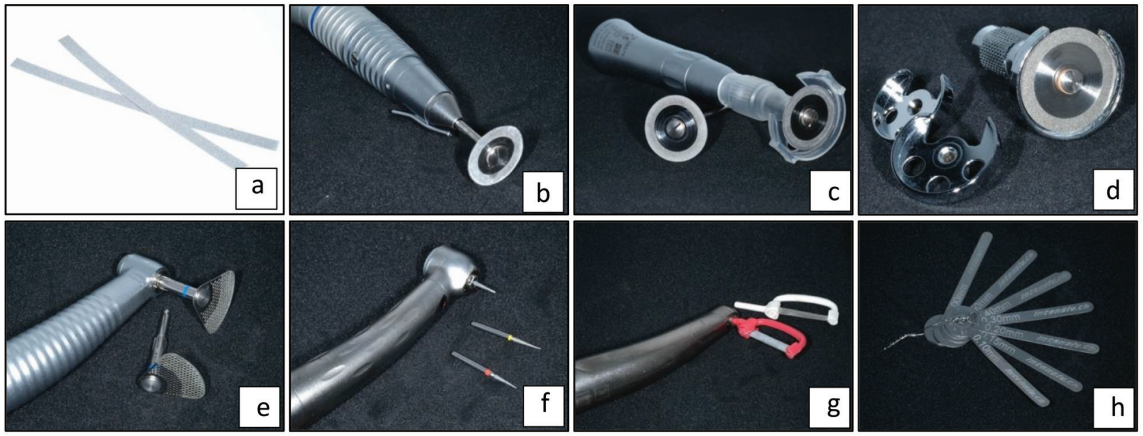

Fig.2 Manual instruments: a) Thin metallic strips: b) Diamond disc in straight handpiece, c) Diamond discs with plastic soft tissue protector, d) Diamond disc with metal soft tissue protectors, e) Oscillating discs in contra angle handpiece, f) High speed airotor diamond burs, g) Diamond strips in contra angle handpiece, h) IPR gauge set.

Conclusion

Interproximal enamel reduction is proven to be the safe method to gain space in the orthodontic treatment, especially non-extraction approach. Since enamel stripping is an irreversible procedure, clinicians must keep in mind the indications, the amount of enamel to be removed, locations, techniques, and most importantly, patient's safety.

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