Air-rotor stripping in orthodontic treatment - a literature review

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Introduction

Interproximal enamel stripping is a technique that could be applied to orthodontic treatment for various purposes. An article of Ballard\(^1\) in 1944 was probably the first publication ever advocating the mesio-distal enamel reduction when a significant right-left imbalance of anterior tooth width existed. Since then, interproximal stripping has been regularly employed for the relief of lower anterior crowding\(^2\)–\(^6\), correction of tooth size discrepancy\(^7\), enhancing post-treatment stability\(^2, 8\)–\(^11\), and cosmetic recontouring of anomalous morphology teeth\(^3, 12, 13\). Formerly, the means of the procedure used to be restricted to abrasive strips and abrasive disks. Also, only the enamel of the anterior teeth was allowed to be reduced due to the old style orthodontic banding systems in the posterior teeth. Nowadays, it is possible to reduce the interproximal enamel of all teeth that we should thank to the development of resin bonded orthodontic appliances. Later, a new technique of interproximal stripping, so called air–rotor stripping has been introduced\(^14, 15\) and has been widely utilized by
orthodontists worldwide as an alternative to extraction or expansion therapy. The purpose of this article is to review the background and benefits of air-rotor stripping, and to address the possible disadvantageous effects of the technique.

Background

Air-rotor stripping technique (ARS) was introduced by Sheridan\textsuperscript{14} in 1985. It is a technique to create space for aligning or retracting anterior teeth by the accumulative removal of interproximal enamel in the posterior teeth. The author\textsuperscript{14} was initially inspired by the theory of Begg\textsuperscript{16} who examined the Australian aboriginal population and stated that the loss of interproximal tooth substance is a natural functional process. Teeth become smaller occluso-gingivally and mesio-distally with age. The lack of such loss in modern population may produce crowding phenomenon. Hence, interproximal stripping of all teeth would be a mimicking procedure of natural tooth wear which may maintain the normal function and stability of the dentition.

The author\textsuperscript{14} also gave Peck and Peck credit for their development of norms for mesio-distal/facio-lingual dimension ratio (MD/FL ratio) of the lower anterior teeth in well-aligned dental arches. They\textsuperscript{3} recommended that, in order to achieve good lower anterior alignment, lower incisors should be reshaped if the MD/FL ratio exceed the norms.

In his first publication, Sheridan\textsuperscript{14} recommended the original stripping technique as follows: a 0.20\textdegree brass wire is placed in the interproximal space to prevent damaging the papilla during stripping, it also acts as a guide for the bur and prevents ledging the interproximal enamel walls. Then, enamel removal is accomplished by means of a 699L tapered crosscut fissure carbide bur with a lateral approach (buccal or lingual) to the interproximal area. A tungsten carbide bur is more advantageous than a diamond bur in the way that the cutting particles on the tip of the diamond bur are quickly worn and it could create frictional heat leading to pain and pulpal damage. The reduced enamel walls are then finished with carbide finishing burs, finishing diamonds, polishing disks, or hand-held finishing strips. Lastly, topical fluoride solution is applied to prevent the formation of secondary caries. Although there have been no studies indicated how much enamel could be exactly reduced, the author quoted the previous research of Peck and Peck\textsuperscript{3} on the thickness of enamel who postulated that 50\% of interproximal enamel can be safely removed and the study of Shillingbourg and Grace\textsuperscript{17} that as many as 8.9 mm of space can be yielded if the procedure is applied to all teeth in the arch.

In the same publication, the author presented a modified procedure using a bur to reduce the enamel on the lingual and labial surfaces until the contact area becomes knife-edge shape. This remaining enamel is then removed with a hand-held metal abrasive strip. The procedure has been claimed to be useful for the stripping of lower anterior teeth where only small amounts of enamel are to be removed.

Later on, Sheridan and his co-workers have continuously improved the air-rotor stripping technique. In 1987, Sheridan\textsuperscript{15} introduced a revision of his original air-rotor stripping technique that the posterior teeth should be aligned and the contact points should be opened prior to the reduction procedure. The most distal interproximal contact is separated by means of a thick separator or an open-coil spring. The contact points are then sequentially stripped from posterior to anterior and teeth are moved distally into the created
spaces like beads on a string. Sheridan and Ledoux\textsuperscript{18}, in 1989, recommended the application of sealant resin to the mechanically stripped surface in order to smooth the roughness on the proximal enamel. They found according to the SME observation that the adherence of the sealant material to the proximal enamel was similar to those observed on the occlusal surfaces of enamel. The sealed surfaces appeared to be as smooth as untreated enamel. The authors inferred that the technique could possibly increase caries resistance. Recently, Ballard and Sheridan\textsuperscript{19} proposed the use of a removable plastic device so-called Essix appliance as an anterior anchor to counteract the anterior vector of force produced by the open-coil spring during the air-rotor stripping procedure.

Besides the contribution of Sheridan, other authors have advocated the modification of the air-rotor stripping technique for the improvement of efficiency and the ease of use. Jarvis\textsuperscript{20} stated that the lateral approach in buccal or lingual direction during stripping is difficult and may unintentionally create notching on the cutting surface. He recommended an occlusal approach by using an air-rotor and a tungsten carbide bur, followed by a series of finishing disk (Sof-Ilex\textsuperscript{®}). He claimed that the occlusal approach is easier and less likely to harm the tooth than the lateral approach. Joseph et al\textsuperscript{21} proposed a combined mechanochemical technique by applying 37\% phosphoric acid in conjunction with a finishing strip after the routine mechanical stripping. The authors claimed that the microabrasive chemical stripping created a relative smooth enamel surface and encouraged the remineralization potential. However, it has been debated that such combined technique resulted in etched, but impenetrable surface that is susceptible to decalcification despite the application of fluoridating solutions.\textsuperscript{22} However, a later investigation by Rossouw and Tortorella\textsuperscript{23} supported the effectiveness of the use of low concentration acid in conjunction with mechanical procedure. A late research by Piacentini and Sfondrini\textsuperscript{22} on the efficiency of various enamel polishing methods after air-rotor stripping at SEM level advocated the use of a 8-straight blade tungsten carbide bur followed by Sof-Ilex\textsuperscript{®} disks. They claimed that the method produced smoother enamel surfaces than intact enamel.

The benefits and drawbacks

It has been well accepted that air-rotor stripping can be used as an alternative to extraction or expansion treatment in mild or moderate (4-8 mm) crowding patients.\textsuperscript{13-15, 19-21, 23-31} The technique is able to reduce the difficulties in extraction cases and the instability of over-expansion in non-extraction cases because it allows transverse arch dimension and anterior inclinations to be maintained.\textsuperscript{31} In addition, air-rotor stripping has been reported to significantly reduces treatment time.\textsuperscript{32} The technique can also be applied to the elimination of tooth-size discrepancies and the enhancement of stability.\textsuperscript{8, 9, 33}

Although air-rotor stripping technique has been recognized for its advantages, clinicians should not utilize the technique without any cautions since the adverse effects of air-rotor stripping on the enamel and the periodontal tissue have been occasionally reported. However, some other studies have not found the drawbacks of the technique. The following part of the review will discuss the controversies of the possible deleterious effects of air-rotor stripping.

Radlanski et al\textsuperscript{34} investigated stripped enamel surfaces at SEM level twelve weeks prior to extraction and reported that furrows of 10-30 microns in depth
and width resulting from the stripping procedure could favor the accumulation of plaque, and that it was impossible to remove plaque from these furrows with dental floss. The authors also stated that, despite the use of fine and ultrafine strips, the stripped enamel surfaces were unable to be polished. As a consequence, it led to an increased risk of dental caries. However, in later research, Radlanski et al\textsuperscript{[15]} reversed their previous conclusion by reporting the low incidence of caries in stripped enamel at SEM level at one year follow up. The finding was in agreement with that of Crain and Sheridan\textsuperscript{[27]} who compared 151 stripped enamel surfaces with 517 untreated surfaces by means of bite-wing radiographs at the duration of two to five years after stripping. They did not find any statistically significant association between proximal stripping and caries susceptibility. However, it must be noted that bite-wing radiographs have been shown to be highly unreliable as caries progression may cross more than half of the proximal enamel thickness before it is detected with clinical radiographs.\textsuperscript{[36]}

Twesme et al\textsuperscript{[29]} stated from their \textit{in vitro} study that stripped enamel surfaces may be more susceptible to the demineralization comparing with intact surfaces. However, their experimental design did not mimic the real intra-oral environment where there is a balancing activity of demineralization and remineralization. An experiment on the permeability of abraded enamel\textsuperscript{[37]} showed that, initially, the abraded enamel was demineralized rapidly. Nonetheless, salivary buffers neutralized the enamel surfaces within minutes, and remineralization subsequently begun within one hour. The rapid rate of intra-oral remineralization exhibited a mechanism for the protection of the enamel against demineralization. The authors explained that mechanical stripping of the enamel surface not only removed the inert enamel surface, but it also created surface porosity resulting in an increased surface area for interacting with remineralizing agents. El-Mangoury et al\textsuperscript{[28]} also found a similar result. They performed a SEM investigation on proximally stripped enamel of the premolars that had been recommended for extraction for orthodontic purpose and concluded that interproximal stripping did not increase the risk of dental caries and there would be a spontaneous remineralization within 9 months after stripping.

It has been assumed that the compressing of interradicular soft tissues and bone could induce periodontal problems.\textsuperscript{[38, 39]} The statement was based on the belief that an adequate space between the teeth at the level of crestal bone is necessary for continuing the gingival health. Closing the stripped spaces could reduce the amount of transseptal bone between teeth and predispose these areas to periodontal disease.\textsuperscript{[39-41]} It may become more difficult to scale or to floss the reproximated contact points.\textsuperscript{[20]} However, Sheridan\textsuperscript{[26]} argued that the closure of stripped space did not differ from the routine closure of a naturally occurring space. In fact, gingival tissue could adapt itself easily, and interdental bone is the most adaptive bone in the body.\textsuperscript{[42, 43]} A number of later studies\textsuperscript{[44-47]} also did not find the association between interradicular width and the prevalence of periodontal destruction. Moreover, some studies\textsuperscript{[6, 8, 15, 48]} even showed patients whose gingival tissues were significantly improved after correction of dental malalignment by selective stripping. Presumably, it may be postulated that the compression of the alveolar bone when the stripped spaces are closed has no link with the risk of periodontal disease.

Some other complications associated with reproximating posterior teeth, which have been
previously reported, are impaired function (food impaction and poor marginal contacts) resulting from an imprecise or careless approach to reduction, sensitivity to extreme temperatures due to over-reduction of the enamel, tooth discoloration from which the pulp irritation is sufficient to cause extensive secondary dentine deposits, and the placement of subgingival contact areas on the stripped teeth.

**Clinical considerations**

It is apparent that there have been diverse opinions as to whether air-rotor stripping is injurious to the enamel and periodontal tissues. Clinicians must take precautions to ensure that the negative effects of air-rotor stripping are eliminated. The followings are some recommended considerations.

1. Air-rotor stripping is not a substitute for extraction. Extraction is still necessary for severe crowding. Stripping may be more appropriate for the resolving of mild to moderate crowding in Class I arch length discrepancies and minor Class II patients whose growth have already ceased. Should there be more than one treatment options, the final decision must be made on the dentist-patient agreement basis.

2. Evaluate the caries potential (DMF scores) and periodontal condition of each patient before the stripping procedure. Stripping can be accomplished only after a careful assessment of the quantity of enamel that can be safely removed and it is contraindicated in patients who have poor oral hygiene or periodontal problems.

3. Inform every patient that the stripped surfaces may be more susceptible to demineralization and plaque accumulation.

4. Up to one half that the enamel thickness could be removed when stripping interproximally. However, since the ability to predict proximal enamel widths is still poor, it would be prudent to take radiographic records prior to stripping.

5. The amount of enamel reduction should be precisely related to the amount of space needed. For example, if 5 mm of crowding exists, then 5 mm of interproximal enamel should be removed.

6. Avoid cutting the interdental tissues

7. Always measure and record the accumulated space.

8. Finish proximal walls as smooth as possible and contour the teeth to resemble its original morphology to prevent wide contacts that might be restricted the space of the gingival papillae.

9. The application of topical fluoride, especially fluoride varnish, is strongly recommended.

**Summary**

Air-rotor stripping is an effective alternative to expansion or extraction treatment in mild to moderate space of deficiency cases. Despite its well-accepted advantages, clinicians must carefully evaluate the enamel to be removed and cautiously perform the procedure so that the best possible finishing of the enamel surfaces are accomplished and the biologic requirements of the oral cavity are met.
References


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Abstract

Air-rotor stripping was first introduced as an alternative to extraction or expansion therapy in orthodontic treatment in 1985. Since then, the technique has been variously modified for the improvement of its efficiency and the ease of use. Air–rotor stripping has been claimed to be advantageous for the relief of mild to moderate crowding without sacrificing premolars or violating the original arch dimension. However, the opinions on the drawback of the procedure, such as demineralization of the stripped enamel, periodontal complication, and so on, have been varied. It is suggested that clinicians should take precautions whenever the technique is clinically applied.

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Key words: air-rotor stripping; interproximal stripping; enamel reduction; orthodontic treatment