

EFFECTIVENESS OF CLEAR ALIGNER THERAPY IN TREATING ANTERIOR OPEN BITE: A LITERATURE REVIEW***Ghada Alaglan**

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Abstract

Orthodontic treatment of open bite is listed among the most challenging tasks faced by orthodontists. Available treatments vary from functional appliances in growing patients to surgical approach in adults. Recently, clear aligners have also been proposed as a treatment modality as a more esthetic and comfortable alternatives to conventional fixed orthodontic appliances. Clear aligners can be used alone or in combination with temporary anchorage devices to treat open bite cases.

Keywords: Anterior open bite, Clear aligners, Skeletal anchorage, Orthodontics.

INTRODUCTION

Orthodontic treatment of anterior open bite is listed among the most challenging tasks faced by orthodontists,¹ mostly because of the mechanisms needed to treat this condition and its high rate of relapse.^{2,3} The vertical incompetence of the arches due to poor dental and/or skeletal position does not allow correct occlusion between opposing teeth. This lack of contact can be caused either by dentoalveolar or skeletal alterations.⁴ The etiology of open bite is multifactorial,⁵ and includes genetic influence,⁶ familial predisposition, non-nutritive sucking habits,^{7,8} tongue thrusting,^{9,10} nasopharyngeal airway obstruction and mouth breathing or unfavorable growth patterns.¹¹ Open bite can result in functional challenges, including speech dysfunction and difficulty eating. In addition, esthetic concerns for patients including but not limited to poor incisor display, excessive gingival display, and poor smile esthetics.¹² In such cases, consultation between the orthodontist, otorhinolaryngologist, and myofunctional therapist becomes necessary before and during orthodontic treatment.¹³ In case of growing patients, early intervention with interceptive functional appliances or speech therapy in order to influence either the residual growth,^{14,15} or to modify negative habits, such as digit sucking or tongue thrusting may improve their condition.^{16,17} Conversely, the treatment options in the absence of residual growth are limited and oftentimes more invasive. An accurate diagnosis of the dentoalveolar or skeletal origin of the malocclusion, via cephalometric analysis needs to be performed.⁴ Solely orthodontic intervention or camouflage such as intrusion of the posterior segments and/or extrusion of the anterior dental segment is an option only in cases of dentoalveolar alteration, whereas surgery is indicated in cases of skeletal dysplasia.¹⁸ This commonly involves maxillary impaction with a Le Fort I osteotomy. After the maxillary impaction, a passive forward autorotation of the mandible reduces the lower anterior face height and the open bite.¹⁹ Although orthognathic surgery has been traditionally advocated as the ideal management of underlying skeletal dysplasia while avoiding undue incisor extrusion, not many patients accept to undergo such an invasive modality, and the

request of dentoalveolar compensation is becoming more and more prominent.²⁰ Some studies reported that successful camouflage treatment with the intrusion of the dental buccal segments can produce comparable treatment effects to orthognathic surgery.²¹ Adult patients seeking orthodontic treatment have increased in recent years, demonstrating a preference for more esthetic and comfortable alternatives to conventional fixed orthodontic appliances.²² Clear aligner therapy was initially developed to correct mild-to-moderate crowding, to close naturally occurring spaces, and to produce dental tipping.²³ Recently, it has been advocated for treatment of more complex cases, including extractions, open bites, and Class II malocclusions.^{20,24}

Is clear aligner therapy alone effective in treating open bite cases?

Clear aligners have been proposed for the treatment of open bite as they offer a comfortable and almost invisible treatment option. Different hypotheses have been suggested to explain the effectiveness of this system in vertical control. First of all, molar extrusion is prevented by the presence of thick plastic material between the opposing occlusal surfaces,^{25,26} in contrast to a potential risk of posterior extrusion with conventional appliance in absence of an adequate anchorage.²⁷ A posterior intrusion has also been proposed due to a "bite block effect". Molar intrusion will result in a closure of the anterior open bite due to counterclockwise rotation of the mandible.^{25,28} In mild cases if this is coupled with anterior extrusion, it can lead to successful bite closure in open bite patients. As long as anterior dental extrusion would not negatively affect the final aesthetic outcomes, based on the incisal show of the patient before treatment.²⁰

Numerous studies have established that this hypothesis might be true. Dayan²⁹ suggested the concept of wearing the aligners for extended periods of time to intrude posterior teeth, thus creating a deeper curve of Spee. Another study by Bowman et al³⁰ shows open bite cases successfully treated using these mechanisms. Using Chewies to exert intrusive forces on posterior teeth can improve the results. Moshiri et al³¹ compared pre-treatment and post-treatment cephalometric analysis of 30 adult patients with anterior open bite treated

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using clear aligner therapy. They found that bite closure was primarily achieved by a combination of counterclockwise rotation of the mandibular plane on average by 0.9 degrees, 0.4 mm of maxillary and 0.6 mm of mandibular molar intrusion, and lower incisor extrusion. Giancotti et al²⁵ in their case report series, stated that when aligners were worn for 22 hours/day for 18–24 months, it resulted in 2 mm maxillary molar intrusion and, thereby, subsequent autorotation of the mandible and improvement of skeletal open bite. Additionally, aligners can extrude the incisors, allowing for dental correction of an open bite. Harris et al²⁷ study showed 0.5 mm of maxillary and mandibular molar intrusion followed by 0.73 degrees of counterclockwise rotation of the mandible. The aligners were not only successful in maintaining the vertical dimension but were also able to reduce the open bite. Extrusion of upper and lower incisors was also noticed. Sangalli²⁰ reported that the correction of the anterior open bite was achieved by a combination of counterclockwise rotation of the mandibular plane, molar intrusion and incisor extrusion. 1.5 mm of molar intrusion was achieved, which was sufficient to accomplish pre-treatment goals, as 1 mm of molar intrusion results in 3 mm of anterior bite closure.³² The relative incisor extrusion accounted for 2 mm. The amount of correction of the anterior open bite was 5.7 mm. Overcorrection was done to counterbalance the possibility of relapse.

However, a criticism of this explanation is that bite blocks of at least 3–4 mm thickness are required to create a bite block effect because they are thick enough to exceed the patient's freeway space and exert a sustained intrusive force on the posterior teeth, whereas clear aligners such as Invisalign have a thickness of 0.76 mm, which is insufficient to exceed the freeway space.²⁰ Additionally, patients typically contact their teeth for approximately 18 minutes per day in the absence of parafunctional activities, which is insufficient to elicit such significant intrusive force.³³ Khosravi et al²⁸ evaluated the ability of clear aligners to control the vertical dimension in open bite patients and reported that the primary mechanism of open bite correction was incisor extrusion. Papadimitriou et al³⁴ in their systematic review recommended clear aligner therapy for treating mild to moderate open bite only since the correction happens mainly through incisor extrusion. Another systematic review by Galan-Lopez et al³⁵ also agrees with previous studies in which the mandibular plane angle remained constant while attempting incisor extrusion. Garnett et al³⁶ did a cephalometric comparison between clear aligners and fixed appliances with miniscrews in correcting anterior open bite in patients with a hyperdivergent growth pattern. It was found that there was no statistical difference in the magnitude of overbite correction between the two groups. The clear aligner group showed an increased amount of lower incisor extrusion. Steele et al³⁷ compared the effectiveness of clear aligners to miniplate-supported posterior intrusion with fixed appliances in treating open bite cases and demonstrated that although both appliances effectively improved overbite, MSPI applied the correction via molar intrusion and counterclockwise mandibular autorotation, whereas clear aligners via maxillary and mandibular incisor extrusion. Other than the insufficient thickness of the aligners leading to more incisors extrusion rather than molars intrusion, it may be possible that the vertical forces generated by clear aligners to treat open bite cases create an indeterminate force system that pits the increased root surface area of the molars against the smaller root surface area of the incisors, leading to incisors extrusion to close the

open bite in the absence of auxiliary vertical anchorage in the posterior.³⁸

Recent techniques facilitating molar intrusion with clear aligner therapy

For mild open bite cases, extrusion of incisors might be an acceptable treatment option, but in more severe cases or patients with an excessive maxillary gingival display, extruding the incisors beyond 1–2 mm is rarely an option from both an esthetic and stability standpoint.³⁹ Following Vela-Hernandez et al⁴⁰ the proper approach to treat an open bite non-surgically should be based on molar intrusion, and following their indications 1 mm of posterior intrusion could close the anterior open bite of about 2.5 mm. In another study they stated that 1 mm of molar intrusion results in 3 mm of anterior bite closure.³² Skeletal anchorage offers a great advantage in its ability to intrude posterior teeth without affecting the vertical position of adjacent or opposing teeth, resulting in insignificant molar intrusion and thus skeletal change through autorotation of the mandible, reducing the mandibular plane angle.³⁸ Lin et al⁴¹ found that the use of miniscrews as an adjunct with bootstrap mechanics to intrude posterior teeth increased the reliability and potentially produced spontaneous mandibular autorotation. Giancotti et al⁴² in their 2 cases report showed that clear-aligner therapy in conjunction with skeletal anchorage provides an adequate intrusion of upper molars in the span of 4–6 months with a consequent counterclockwise rotation of the mandible. Pinho and Santos²⁶ reported that after 7 months of placing miniscrews on the mandibular shelf in combination with clear aligners, a significant improvement in vertical dimension with counterclockwise rotation of the mandible was observed, therefore allowing the camouflage of skeletal problems without the necessity of performing true incisor extrusion to avoid a gingival smile as a side effect of anterior extrusion.

Other effective technique for facilitating tooth movement focus on surgical injuries to the bone in order to induce a regional acceleratory phenomenon (R.A.P.) effect.⁴³ Although this approach is unreliable in terms of changing the rate of orthodontic tooth movement over the duration of treatment,⁴⁴ it appears to facilitate specific tooth movements and reduce the risk of root resorption. A recent study done by Greco et al⁴⁵ found this alternative approach to be successful. As mandibular superimposition showed a 2.5 mm molar intrusion without root resorption and a significant reduction of mandibular plane angle by 4 degrees with consequent counterclockwise rotation of the mandible. The use of aligners in conjunction with micro-osteoperforations may eliminate the need for external auxiliaries, simplifying the facilitation process to a single surgical procedure that is more favorable for molar intrusion in the mandibular arch.⁴⁵

Limitations

The majority of studies included in this review were case reports which is considered a low level of evidence. The absence of sample randomization procedures, the absence of proper control groups, the absence of appropriate blinding procedures, and the small sample sizes were all significant limitations. It is recommended that future researchers include RCTs in order to increase the power of the studies for estimating the effects.

Stability of anterior open bite correction using clear aligners has not been well studied. Therefore, further research in this field needs to be done.

Conclusion

Although clear aligner therapy alone seems to be very effective in controlling the vertical dimension and treating mild open bite cases via incisors extrusion, its effect on molar intrusion is minimal and insufficient to manifest as an appreciable skeletal change. When skeletal anchorage is used in combination with clear aligners, more promising results were noted.

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