



An Update on Present and Future Considerations of Aligners

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ABSTRACT

This report reviews the orthodontic treatment of six different patients who received removable aligners. These cases include correction of deep overbite, open bite, mild-to-moderate crowding, large overjet, cases requiring premolar extractions, the presence of multiple restorations, and cases requiring periodontal-restorative treatments, the improved periodontal status with aligners compared to fixed appliances and the use in teenagers. This report demonstrates that a wide range of cases can be effectively treated, provided the cases are thoroughly reviewed at an early stage process using Invisalign's ClinCheck software, which will show the specific details of all consecutive appliances prior to any treatment being started so as to determine the biologic and biochemical feasibility of treatment.

The Invisalign appliance was introduced in literature in 2000 by authors Boyd, Vlaskalic and Miller.¹ Since then, more than 400,000 patients around the world have had this treatment.² Although another clear, removable appliance has recently been introduced by OrthoClear, there is no literature demonstrating efficacy of this appliance. Since its introduction, there have been numerous reports of the effectiveness of Invisalign and two clinical trials that have studied this appliance.³⁻²³ This literature has demonstrated that the use of this appliance is successful for many different types of tooth movement.



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Disclosures / Robert L. Boyd, DDS, MEd, owns a small amount of stock in Align Technology, which makes Invisalign. Mohamed Fallah, BDS, MDS, has part-time employment with, and also owns stock in, Align Technology.

The first clinical trial found tipping movements, rotations of incisors, and space closure as the most predictable movements.²⁰⁻²¹ However, this trial was limited to studying different appliance materials that are no longer used. New and better-performing materials have been upgraded for use in these appliances since then. This preliminary study also focused on the efficacy of a one-week versus a two-week change of appliance. The current protocol is two weeks of wear for each appliance. A more recent longitudinal clinical study reported that, in addition to tipping, space closure and anterior tooth rotations, intrusion was also successful.²³ Most notably, both of these clinical studies showed a statistically significant reduction of plaque and gingivitis during treatment. However, numerous other studies have shown increased plaque and gingivitis associated with the use of fixed appliances and the need for a highly structured preventive program to minimize these effects on periodontal tissues and enamel.²⁴⁻²⁹

Feasibility of Treatment

After the initial examination of a patient, the primary decision to be made is whether they can be effectively treated with a removable aligner. It is most important that this decision takes into account the level of expertise and experience of the dentist in using the aligner. For example, as a service for the dentist, digital photographs can be e-mailed to Align Technology for an evaluation regarding the feasibility of the treatment. A response will be provided to the dentist via e-mail within 48 hours.²

A 2004 article by Spears in the *Journal of the California Dental Association* showed that patients who require minor restorative dentistry and/or bleaching, can be good candidates for orthodontic treatment.³⁰ The author further concluded that these patients will be more likely to accept less invasive restorative dentistry and orthodontic treatment than exten-

sive full coronal restorations (Case 1).

Another group of patients are teenagers who wish to improve their esthetics but are not interested in having fixed appliances (Case 2).

Many patients will only have complaints about the appearance of their anterior teeth. These patients can be good candidates for aligner treatment, even by a less-experienced dentist in conventional orthodontic treatment with fixed appliances, if there is an acceptable posterior occlusion (Case 3). In Case 3, there was also a pronounced decrease in the redness and swelling of the gingiva between pretreatment and post-treatment intraoral photos.

One of the most commonly encountered types of patients who wish to have aligner treatment are individuals who have previously received orthodontic treatment using fixed appliances (Case 4) or who do not want fixed appliances for their present orthodontic treatment. This is usually because esthetic concerns may be a significant factor, as many patients may not want to show metal or even clear fixed appliances in their smile.

Another type of patient who is a good candidate may be an individual with a history of successful periodontal treatment. This is primarily because of the previously discussed decrease in plaque and gingivitis associated with aligners versus the increased plaque and gingivitis associated with fixed appliances^{3,5,22-23} (Case 1).

Patients with short roots may also be better candidates for aligners as a recent University of Florida study has shown no measurable root resorption in their longitudinal study of 100 consecutive aligner-treated patients (Wheeler T. in preparation). This is in contrast to fixed appliances, which generally show an average of 10 percent of patients having clinically significant root resorption of 3 millimeters or more.³¹⁻³²

An interesting finding with the use of the aligners is that patients who have

a shallow overbite, an edge-to-edge bite, or a slight open bite, can experience improvement in the overbite by approximately 1-2 mm during treatment³ (Cases 2 and 4). This is most likely due to the intrusive effect on the posterior teeth because of the increased interocclusal distance established when the patient wears the appliance and the resultant biting force. This is in contrast to fixed appliances, which may often cause a decrease in overbite in these types of open bite patients due to their generally extrusive nature (Cases 2 and 4).

Patients who have excessive wear on their teeth from grinding or bruxing may also be good candidates for aligners because the appliance acts in a similar fashion to a nightguard during treatment (Cases 1 and 4). After treatment, aligner retainers are worn indefinitely at night, which can potentially lessen the effects of nocturnal clenching, grinding, or bruxing. A recent study by Nedwed and Meithke et al. showed that even among patients who had a history of parafunctional habits, i.e., clenching, grinding and bruxing, that aligner treatment had no increases in myofascial discomfort, but rather decreases as compared to those with fixed orthodontic appliances.³³ The authors attributed this to the double splint effect of the appliances.

Another advantage of aligners is found in patients with extensive porcelain, gold, or highly restored mouths. Bonded, fixed appliances are more difficult to retain in place during treatment on such surfaces as porcelain, gold and metal, and potential damage can occur on these surfaces at the time of debonding (Case 5).

Improvement of deep overbites is generally successful with aligners because of its predictable nature with intrusive orthodontic mechanics³ (Case 5). Another advantage of aligners for patients with deep overbites is the disclusion of the teeth achieved, which eliminates problems encountered with

CASE 1



1a.



1b.



1c.



1d.



1e.



1f.



1g.



1h.



1i.



1j.

Figures 1a-e show the pretreatment views of a 52-year-old woman who had been successfully treated for generalized moderate periodontitis and whose chief complaint was “crooked front teeth and space between my front teeth.” This patient agreed to aligner treatment followed by the placement of a crown on tooth No. 9. She was able to whiten her teeth during treatment as the aligners can effectively be used for this purpose.

Figures 1f-j show still photos of the pretreatment computer models used with ClinCheck software.

CASE 1



1k.



1l.



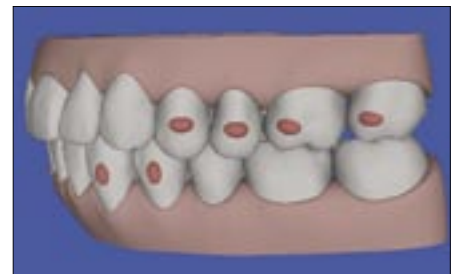
1m.



1n.



1o.



1p.



1q.



1r.

Figures 1k-m show the post-treatment results. A new crown was placed on tooth No. 9 and tooth whitening was completed. Note the remarkable similarity of the initial treatment projection in the ClinCheck software and the final clinical results.

Figures 1n-r show the post-treatment still photos of ClinCheck.

CASE 2



2a.



2b.



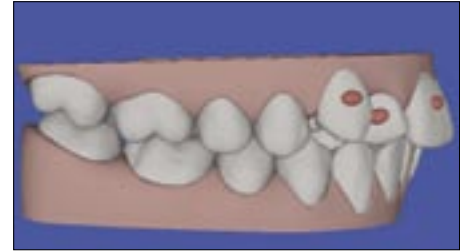
2c.



2d.



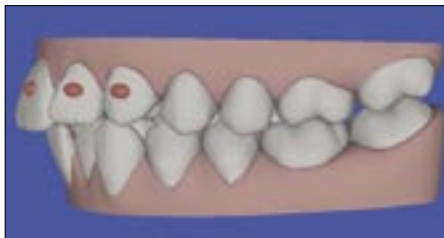
2e.



2f.



2g.



2h.



2i.

Figures 2a-e show a 14-year-old female who presented with a chief complaint of “my front teeth are crooked and do not touch in the front.” She refused to have fixed appliances.

Figures 2f-j show still photos of the pretreatment computer models used with ClinCheck software.



2j.

CASE 2



2k.



2l.



2m.



2n.



2o.



2p.



2q.



2r.



2s.

Figures 2f-j show still photos of the pretreatment computer models used with ClinCheck software.

Figures 2k-o show post-treatment results with closure of the open bite and excellent alignment of the teeth. Only one sequence of 20 upper and lower aligners and 13 months of treatment time were needed as this patient was very compliant with wearing her appliances.

Figures 2p-t show still photos of the final positions of the ClinCheck computer-generated models.



2t.

CASE 2



2u.



2v.



2w.



2x.



2y.

Figures 2u-y show the almost three-year post-treatment results, which show good stability of the correction of the open bite with only night-time wear of the final aligners as retainers.

CASE 3



3a.



3b.



3c.



3d.



3e.



3f.



3g.



3h.



3i.

Figures 3a-e show a 17-year-old female who had generalized gingivitis and a chief complaint of "crooked front teeth."

Figures 3f-j illustrate the final results showing a dramatic reduction of gingivitis just from the wearing of the aligner appliance and good alignment of the teeth.



3j.

CASE 4



4a.



4b.



4c.



4d.



4e.



4f.



4g.



4h.



4i.

Figures 4a-e show the pretreatment intraoral views of a periodontally healthy 29-year-old woman who presented with a chief complaint of “crowded teeth.” Moderate upper and lower crowding and anterior and posterior cross-bites were present with a very shallow (less than 1 mm) overbite.

Figures 4f-j show the post-treatment results from 15 months of nonextraction treatment. Note the deepening of the overbite and the correction of crowding, as well as the anterior and posterior cross-bites. The slight posterior open bite seen here is a normal occurrence with aligners, which will close in approximately six to eight weeks after the patient changes to night-time only use of their retainers.



4j.

CASE 5



5a.



5b.



5c.



5d.



5e.



5f.



5g.



5h.



5i.

Figures 5a-e show pretreatment intraoral views of a 54-year-old patient whose general dentist had asked the patient to have improved alignment of her anterior teeth and correction of her deep overbite prior to receiving new crowns for teeth Nos. 7 to 10. Note the extensively restored dentition with a total of nine crowned teeth with either gold surfaces or porcelain.

Figures 5f-j show post-treatment results with correction of the deep overbite and crowding, and improved positions of the new crowns present from teeth Nos. 7 to 10. (*Restorative dentistry by Dr. Brian Kenyon, University of the Pacific.*)



5j.

CASE 6



6a.



6b.



6c.



6d.



6e.



6f.



6g.



6h.



6i.

Figures 6a-f show intraoral views of a 31-year-old woman who presented with a chief complaint of a “large overbite.” Note the very large overjet (13 mm) in Figure 6d, which was caused by significant dentoalveolar protrusion of the maxillary arch. The treatment plan was to extract both upper first premolars and to retract the upper anterior teeth to the positions of the lower anterior teeth.

Figures 6g-i show use of a three-tooth segment of fixed appliances on the canines, second premolars and first molars on both right and left sides facing the upper first premolar extraction sites. This was done because the clinician noted about 10 degrees of tipping had occurred about eight aligners from the end of treatment. Fixed appliances were used for only five months in conjunction with the final eight upper aligners, which were relieved at the gingival one-third for placement of the fixed appliances and archwires.

CASE 6



6j.



6k.



6l.



6m.



6n.



6o.

Figures 6j-o show the post-treatment intraoral views with acceptable root parallelism and complete correction of the excessive overbite and overjet.

fixed appliances and clearance between incisors when teeth are brought together. Dental anterior and posterior crossbites can also be effectively treated by aligners (Case 4) because of this disclusion effect, as long as the cross-bites are dental and not skeletal in origin.

Case 6 shows the treatment of a severe class II division one patient with 13 mm of overjet and a deep overbite. Both upper first premolars were removed to facilitate the retraction of the upper anterior teeth due to the maxillary dentoalveolar protrusion present. Segmental fixed appliances were used during aligner treatment for the last eight stages to upright the roots, which had started to tip (total time in fixed segmental appliances was five months). The aligners were still worn during these eight stages to continue to move the other teeth,

to provide a type of base arch for control of arch form during the root uprighting (thus preventing the need for upper anterior fixed appliances), and for guidance of the crowns of the tipped teeth into their correct position reflected in the final ideal positions of the crowns with the aligner. Tipping of teeth had been a problem during the initial years of aligner treatment for premolar extraction cases, but new protocols using thicker buccolingual diameter (1 mm) types of rectangular attachments have more recently allowed a higher percentage of patients to have premolar extraction treatment completed with aligners only.^{3,5,21,22,34}

The main issue is to not let the teeth tip severely, i.e. more than 10 degrees, during space closure as that can lead to an extended treatment time to upright the severely tipped teeth.

Discussion

Recently, Nelson, described several advantages of the aligner software that were summarized from a meeting.^{34,36} He stated that “This topic grows dramatically each year as practitioners figure out how to use it (aligners) to an advantage. This year the big topic was to do the first ClinCheck with no interproximal reduction (IPR) planned, to provide a virtual diagnostic set up. Then decide on the appropriate strategy to treat the case: distalization, elastics, extraction, IPR, expansion, or some combination. This gives you a therapeutic diagnostic setup — very valuable.” Other advantages cited by Nelson included “Evaluating anchorage with the superimposition or surgical simulation tools” and that “The ClinCheck set-up can be used for diagnosis and treatment planning — evaluate the need for IPR, expansion, extraction,

distalization, or proclination" as well as:

- Verifying that the technician has performed modifications,
- A consultation device to show treatment limits to patient,
- A communications tool to e-mail the abbreviated ClinCheck to patients and to referring doctors,
- Verifying that the aligner is tracking,
- Evaluating anchorage with the superimposition or surgical simulation tools and staging, and
- Addressing the patient's chief concern (of anterior tooth alignment) at the beginning of the series, and applying simultaneous movements to reduce the overall number of aligners."

Boyd further defined these unique benefits of ClinCheck by noting that the initial display of all of the stages throughout treatment allows the doctor to determine the biomechanical and biological feasibility of treatment by analyzing the pathways that the teeth are moved along during treatment.^{35,37} The ability of ClinCheck to perform these functions is a unique advantage of aligners that has been secured by a number of patents. Specifically, Invisalign can make and number more than two stages of appliances before starting treatment, while still allowing the doctor to make changes at any time by doing a mid-course correction or case refinement with or without a new impression. Other companies like OrthoClear can only display two stages at a time. This prevents an overall look at the staging initially and requires the doctor to re-examine the staging at intervals of only two stages at a time. This would be very difficult to do on a case like those shown in this article as there were between 20 to 45 stages of treatment in these cases.

Summary

This article presented six patients' orthodontic treatments using the recently developed aligner appliance system.

These treated cases show that a wide range of cases can be effectively corrected. The key to success is for the doctor to thoroughly review the entire staging process using ClinCheck software, which show the details and pathways of all of the individual tooth movements of all consecutive appliances in entirety before any treatment is started to determine the biologic and biomechanical feasibility of treatment. ■■■■

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