Correction of severe tooth rotations using clear aligners: a case report

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Background: The present adult patient case report shows the correction of a crossbite malocclusion and severe tooth rotations treated with the Invisalign system.
Methods: A 27-year-old female with a dental crossbite (24, 34), severe rotations of two lower incisors (more than 40°) and malalignment of the upper and lower arches is described. The Invisalign system was treatment planned to correct the malocclusion.
Results: The treatment goals of crossbite, rotation and malalignment correction were achieved after 12 months of active aligner therapy. The overbite improved (2.5 mm before treatment, 1 mm at the end); the dental crossbite, the crowding and the severe tooth rotations (with a mean of 2° of improvement per aligner) were corrected.
Conclusions: After treatment, the dental alignment was considered excellent. The presented case indicates that the Invisalign system can be a useful appliance to correct a dental malocclusion involving severe rotations.

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Introduction

In recent years, increasing numbers of adult patients have sought orthodontic treatment\(^1\) and expressed a desire for aesthetic alternatives to conventional fixed appliances.\(^2\) The possibility of using clear overlay appliances to achieve an orthodontic result was introduced in 1946, when Kesling\(^3\) devised the concept of using a series of thermoplastic tooth positioners to progressively move malaligned teeth to improved positions.

In 1997, Align Technology (Santa Clara, CA, USA) adapted and incorporated modern technologies to introduce the Invisalign system which made Kesling’s concept a feasible, efficient and effective orthodontic treatment option. In 2000, Boyd et al.\(^4\) published the first case report on the use of clear aligners and indicated that the primary benefit of the Invisalign appliance was the superior aesthetics during treatment, compared with metal braces.

The Invisalign system\(^5,6\) is based on a clear sequential appliance (aligners) made from a translucent thermoplastic material, which is worn for at least 20 hours per day. According to current protocols, the appliances are replaced on a bi-weekly regimen which incorporates a progressive alignment of up to 0.25 mm translation or up to 2 degrees of rotation per tooth per aligner.

Malocclusions treated with the Invisalign system initially involved only mild crowding of 3-6 millimetres.\(^7\) Recent data has expanded the use of this appliance to incorporate molar distalisation,\(^8\) extraction cases,\(^9\) the treatment of open bites,\(^10\) crossbites,\(^7\) deep bites,\(^11\) Class II\(^8\) and Class III corrections\(^12\) and orthodontic-periodontic problems.\(^13\)

Rotation is an orthodontic movement reported to be difficult to achieve and control with the Invisalign system. Previous studies\(^14,15\) have demonstrated that aligners were not able to control the rotation of canines requiring rotational movements greater than
than 15 degrees, which underlined the fact that the effectiveness of canine derotation was questionable.

Recently, many new biomechanical features have been promoted by Align Technology to improve the predictability of aligner treatment. In particular, the G3 and G4 platforms introduced a collection of newly engineered attachments to improve control of desired tooth movements, including dental rotation and root tipping. The present case report describes an adult patient in whom the correction of a crossbite malocclusion with severe tooth rotations was successfully achieved with the Invisalign system.

Case report

A 27-year-old female patient with a dental crossbite (24, 34), severe rotations of two lower incisors (more than 40°) and malalignment of the upper and lower arches presented for orthodontic treatment (Figure 1). Informed consent was obtained from the patient who underwent examination and record taking. This involved clinical, orthodontic and temporomandibular disorder (TMD) evaluations, a radiographic assessment (panoramic), lateral cephalometry (Figure 2), stone casts, intra-oral (Figure 1) and extra-oral photos, and upper and lower arch impressions to generate a ClinCheck® assessment.

The clinical examination revealed a molar and canine Class I relationship, an overjet of 1 mm, an overbite of 2.5 mm, a crossbite between teeth 24 and 34, upper and lower crowding, and severe rotations of lower incisors (32 rotated 45° and 42 rotated 44°). The assessment of the temporomandibular joints revealed no signs and/or symptoms of TMD.

Cephalometric analysis

Cephalometric analysis showed a skeletal Class I-III relationship according to Steiner with an ANB angle of -1 degree (mean of 2° ± 2°), a hypodivergent craniofacial form indicated by a SN-GoGn angle of 27 degrees (mean of 32° ± 4°), an interincisal angle of
145 degrees (mean of 135° ± 5°), a counterclockwise growth rotation according to Siriwat and Jarabak, with a PostHt/AntHt ratio of 72% (mean of 60-64%) and a counterclockwise growth rotation according to Bjork of 387 degrees (mean of 396° ± 6°).

**ClinCheck® and aligners**

Invisalign treatment was planned to correct the dental crossbite, the severe rotations of 32 and 42 and the upper and lower malalignment. The final ClinCheck® (version 2.9, Align Technology Inc., Santa Clara, CA, USA) provided 17 aligners for the upper arch and 23 aligners for the lower arch (Figures 3 and 4). The duration of therapy was assessed to require approximately 12 months. Each aligner was to be worn for two weeks. No inter-proximal reduction (IPR) was indicated for the correction of the crowding. Retention attachments were planned on several upper teeth (13, 14, 23, 24, 26, 27) and on several lower teeth (32, 33, 34, 36, 42, 43, 44, 45).

Treatment progress was checked every 4 weeks (2 aligners every month) using the ClinCheck® analysis to evaluate changes, patient compliance and bonded attachment stability. A new aligner was inserted at each appointment. The precise relationship and connection between the attachments, the aligner and the teeth, provided an indication of the positive progress of treatment. As compliance is critical in all orthodontic therapy, the patient was instructed to wear the aligners full time, except for eating and tooth brushing. The aligners were worn for a minimum of 20 hours per day.

**Results and Discussion**

A patient with a dental crossbite, severe rotations of lower incisors and malalignment of the upper and
lower arches was treated with the Invisalign appliance. Patient compliance was high throughout treatment and excellent oral hygiene was maintained. The molar and canine Class I relationships were maintained, as well as the overjet. The overbite improved (2.5 mm pretreatment, 1 mm post-treatment); the dental crossbite, the crowding (Figure 5) and the severe tooth rotations (with a mean of 2° of correction per aligner) were corrected (Figure 6). No obvious root resorption was radiographically evident at the end of therapy (Figure 7). A lower fixed retainer was bonded from the right first premolar to left first premolar to maintain lower incisor alignment. Retention in the upper arch was provided by the last aligner used as a nocturnal removable retainer.

In 2003, Joffe21 defined the criteria for selecting Invisalign patients and emphasised that caution should be taken in specific malocclusions involving severe tooth rotations (more than 20°). In the presented case, a correction of 45 degrees and 44 degrees for teeth 32 and 42 respectively, was achieved with 23 lower aligners, using accepted treatment protocols. The rotated incisors were derotated approximately 2 degrees per aligner and the final result was achieved in 12 months. This result may be due to the recent significant improvement in Invisalign technology which has allowed the treatment of more difficult malocclusions over a shorter time. The introduction of the G3 and G4 platforms with new smart force features has also potentially allowed more predictable tooth movement.

**Conclusion**

The Invisalign system can be a useful therapeutic tool to correct a dental malocclusion involving severe rotations. The presented case confirmed that:

1. The correction of a crossbite in an adult patient is possible with clear aligners.
2. Severe tooth rotations of lower incisors (up to 45°) can be corrected with clear aligners.

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