



A new approach to correction of crowding

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The practice of orthodontics is faced with new trends. Adults are increasingly aware of the influence of appearance in their personal and professional lives. A 1999 study showed that the number of adults seeking orthodontic care has been declining. Furthermore, this study concluded that this trend is not likely to improve without a biological or technological breakthrough.¹ Adults make up only a small percentage of the patients in orthodontic practices in the United States.² Possible explanations for the small number of adult patients include fear of pain or discomfort and esthetic concerns associated with general orthodontic treatment.³ Adults are also more conscious of discoloration and unpleasant odor related to orthodontic treatment. Moreover, hygiene and periodontal health are confounding factors associated with adult treatment.⁴ Adults are more likely to have bone and attachment loss than are adolescents. In addition, an increasing number of adults seeking orthodontic care present with relapsed orthodontic treatment. The degree of relapse depends on the normal events of growth and aging after treatment. There is no decisive way to distinguish between normal age-progressive events and those due to relapse.^{5,6} Some patients with orthodontic relapse are apprehensive about going back into braces. Eventually, if the relapse is excessive, fixed appliances are the only option for treatment. However, a new system has been proposed to treat orthodontic relapsed cases.

Align Technology's Invisalign system was introduced in 1997 as a new orthodontic tool. This product offers adult patients full orthodontic treatment with an esthetic appliance.⁷ Through the use of computer-assisted technology, Align Technology can scan a patient's study models and provide a virtual treatment

setup. This virtual treatment, called ClinCheck, is a 3-dimensional view of tooth movements required to achieve the desired treatment result. These tooth movements occur in stages. A new clear plastic tray, called an aligner, is fabricated for each stage. By wearing these aligners in sequence, the patient can achieve the final treatment result. Similar appliances have been used to achieve minor tooth movements. Although the results of these devices are satisfactory, they require manual work, which is both costly and vulnerable to human error. Invisalign has introduced a new technology that increases treatment options for dental practitioners and their patients. This product addresses the appearance issues of esthetically conscious people who would otherwise refrain from orthodontic treatment. Therefore, it is an added tool at the dental practitioner's disposal for treating patients who decline orthodontic treatment.

This case report focuses on the treatment of a patient with severe crowding due to relapse, treated with the Invisalign system. This treatment offered the patient a removable esthetic appliance that facilitated oral hygiene while obtaining excellent clinical results.

DIAGNOSIS AND ETIOLOGY

The patient was a 31-year-old white man whose chief complaint was anterior crowding and relapse of his original orthodontic treatment, which included the extraction of 4 premolars (Figs 1 and 2). His medical history was unremarkable, with no reported allergies and medications. In the frontal view, his face was oval and symmetric. Lips were competent at rest, with 10 mm of incisor display on smiling. Maxillary and mandibular midlines were coincident with the facial midline. The profile was slightly convex, with mild retrusion of the maxillary lip. Intraorally, the patient had excellent oral hygiene with no dental restorations or caries. He had Class I molar and canine relationships. Crowding was moderate, measuring 7 mm in the mandibular arch and 4 mm in the maxillary arch, with posterior segments tipping lingually. He had narrow, V-shaped arches and no tooth-size discrepancy based on the Bolton analysis. Overjet was 4 mm, and a 1.5 mm open bite was present between the maxillary right

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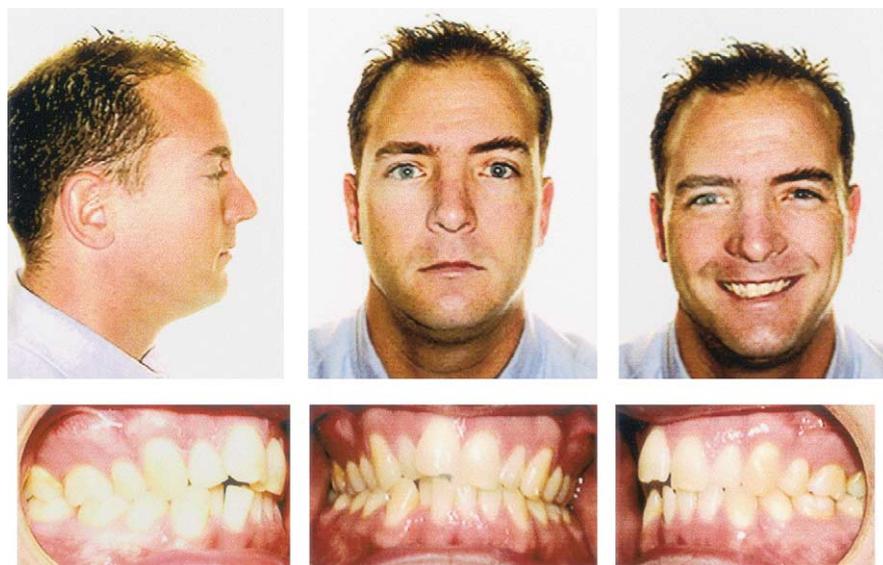


Fig 1. Pretreatment facial and intraoral photographs.

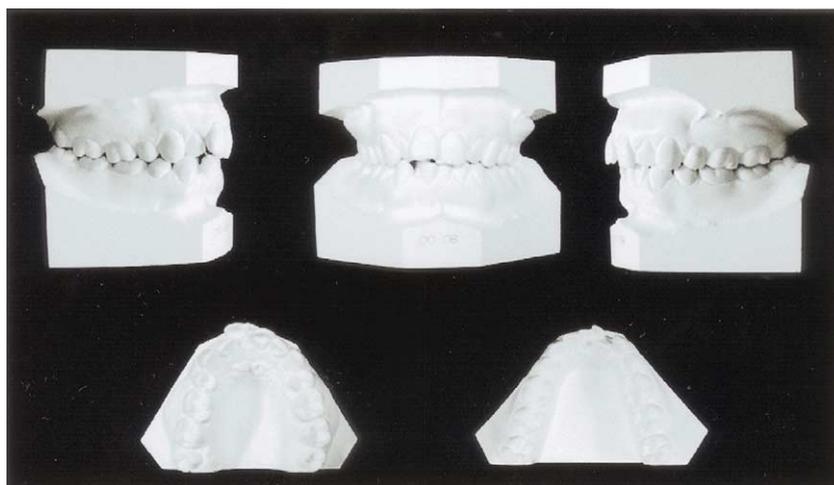


Fig 2. Pretreatment models.

central incisor and the mandibular right central incisor. He showed a mild crossbite between his maxillary right lateral incisor and mandibular right canine. His periodontal status was unremarkable, and no pathologies were noted on his radiographs (Fig 3). The patient exhibited good bone density and bone level and normal root lengths. Cephalometric evaluation showed that he had a Class I skeletal relationship, with an ANB angle of 3° ; the SNA angle was 80° , and the SNB angle was 77° . The maxillary incisors were in reasonable positions, with mild flaring. The mandibular incisors exhibited a retroclined position. Skeletal measurements in both the sagittal and vertical dimensions showed that this patient was within normal limits. (Fig 4, Table)

TREATMENT OBJECTIVES

The main treatment objective was to expand both arches to change the arch form. Expansion would also provide space for anterior alignment and help alleviate crowding to improve the patient's smile. Adequate buccal bone was present, permitting expansion of the posterior teeth. In addition to expansion, proclination of the incisors would assist in resolving the anterior crowding. This was permissible due to lack of lip protrusion, and because the interincisal and nasolabial angles were obtuse. Finally, the slight anterior open bite would be closed by placing attachments on the maxillary incisors to close the open bite and facilitate the



Fig 3. Pretreatment panoramic radiograph.



Fig 4. Pretreatment cephalogram.

TABLE. Pretreatment and posttreatment cephalometric values

Measurements	Pretreatment	Standard	Posttreatment
SNA	80°	82°	80°
SNB	77°	80°	77°
ANB	3°	2°	3°
MP-SN	31°	33°	31°
U1-NA	19°	22°	25°
U1-NA	1 mm	4 mm	5 mm
L1-NB	2 mm	4 mm	5 mm
L1-NB	17°	25°	25°
L1-MP	89°	94°	100°
U1-L1	153°	135°	139°

U, Maxillary; L, mandibular.

correction of crowding. The position of the left third molars would be maintained, because of aligner limitation in correcting third-molar crossbites. Furthermore, correcting this crossbite might create premature contacts that could lead to an anterior open bite and temporomandibular joint problems.

TREATMENT ALTERNATIVES

Several possible alternatives were proposed to the patient to achieve the treatment objectives:

1. Conventional fixed appliances. The patient rejected fixed appliances for esthetic reasons. He had previously had conventional fixed appliance treatment and did not want to go through the same therapy.
2. Esthetic fixed appliances. Although this was a good treatment option, the patient was very concerned about hygiene because of his first experience with fixed appliances.
3. Spring retainer with reproximation for limited treatment. This appliance offers a good result for anterior alignment only, but excessive reproximation is needed to achieve the ideal treatment goal. Also, with the spring retainer, the treatment would be limited, because no expansion can be achieved, and the arch constriction would not be addressed.
4. Invisalign esthetic appliance system. Invisalign treatment was ideal for this patient because it addressed his esthetic and hygienic concerns. Moreover, the treatment time with Invisalign was comparable with that for conventional fixed appliances.

TREATMENT PROGRESS

Polyvinylsiloxane impressions, a prescription form, and the required orthodontic records were submitted to Align Technology. Plaster models were detailed and scanned to obtain a 3-dimensional image. Using Invisalign proprietary Treat software, an operator programmed a virtual treatment plan following the treating doctor's instructions.

The final virtual treatment plan was presented in ClinCheck via the Internet to the treating orthodontist (Fig 5). The treatment involved expansion of both arches and proclination of the anterior teeth. The treatment was reviewed and accepted by the treating orthodontist and the patient. ClinCheck predicted 33 maxillary and 32 mandibular stages. Individual aligners were fabricated for the corresponding stages and sent to the clinician. Before delivery of the first aligner to the patient, composite attachments were bonded on the maxillary incisors with the attachment template provided by Invisalign. The purpose of the attachments was to facilitate extrusion and rotation of the incisors. The aligners were to be changed every 14 days or at the discretion of the treating orthodontist. In this case, the patient changed his aligners every 14 days until the expansion was completed. Once expansion was achieved, he was instructed to change the aligners every 10 days. Therefore, the treatment lasted 52 weeks (12 months) instead of 66 weeks as per the Invisalign

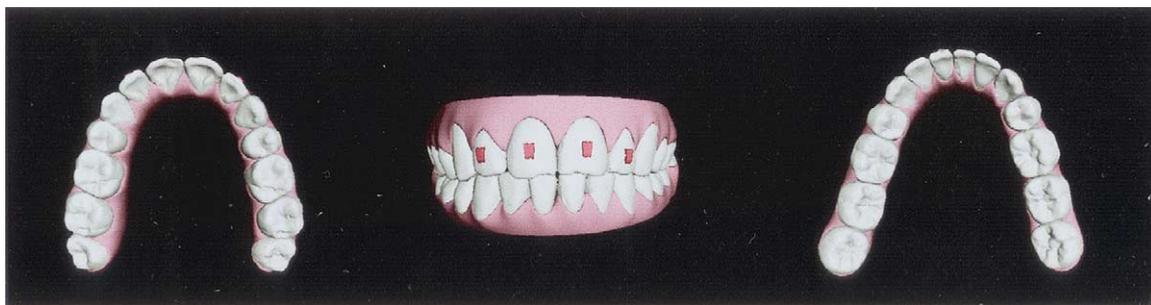


Fig 5. Final virtual treatment.

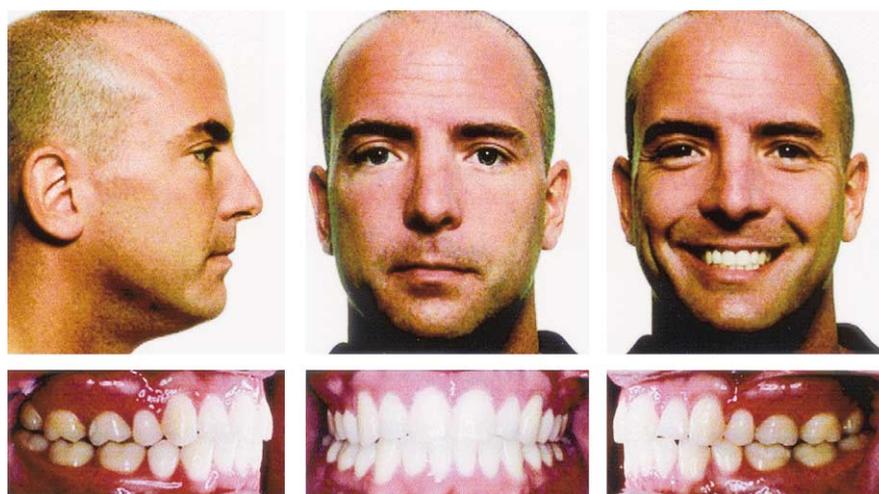


Fig 6. Posttreatment facial and intraoral photographs.

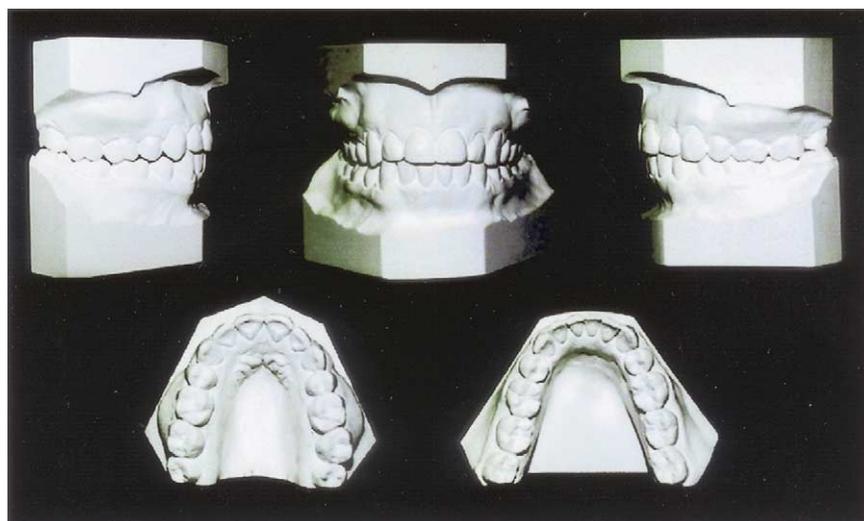


Fig 7. Posttreatment models.

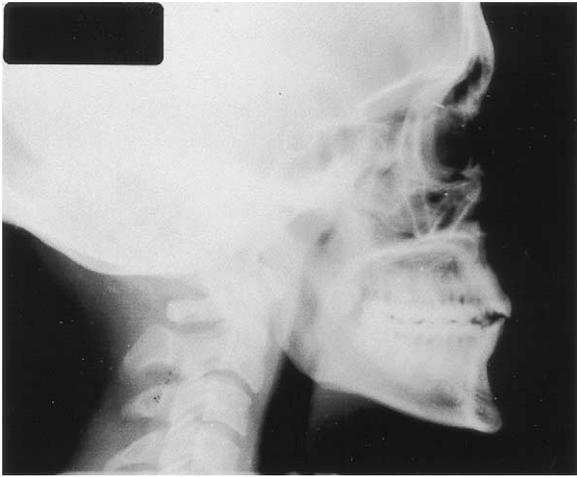


Fig 8. Posttreatment cephalogram.

recommendation. The patient was monitored every month and rescheduled very few appointments. No difficulties were encountered during the treatment. He became accustomed to the appliances after a few days, and no detectable change in speech was observed.

TREATMENT RESULT

The final treatment result was satisfactory. The patient displays a broader smile with a significant show of maxillary and mandibular teeth (Fig 6). The posterior segments were expanded and uprighted by at least 2 mm. The anterior teeth were proclined, while the posterior occlusion and the midlines were maintained. Posterior occlusion on the right side appeared to be opened. This might be due to the minor intrusion of the right posterior segment by the thickness of aligner material during treatment. This bite opening could also be attributed to the expansion. Anterior alignment was achieved without interproximal reduction (Fig 6). This was very important because other removable treatment alternatives would have required removal of tooth structure. Despite the transverse correction, the left third molars were maintained in crossbite (Fig 7). This was intentional because of the possibility of opening the bite and compromising the overbite. Another concern was the development of posterior interarch interferences and other deleterious outcomes associated with it. The maxillary incisors were leveled, and the overbite improved by using composite attachments on these teeth. Although the overbite was improved anteriorly on the right side, it was decreased on the left and was shallow overall. This resulted in a reverse curve of the maxillary incisor edges, especially the lateral incisors. The mandibular incisor alignment and leveling

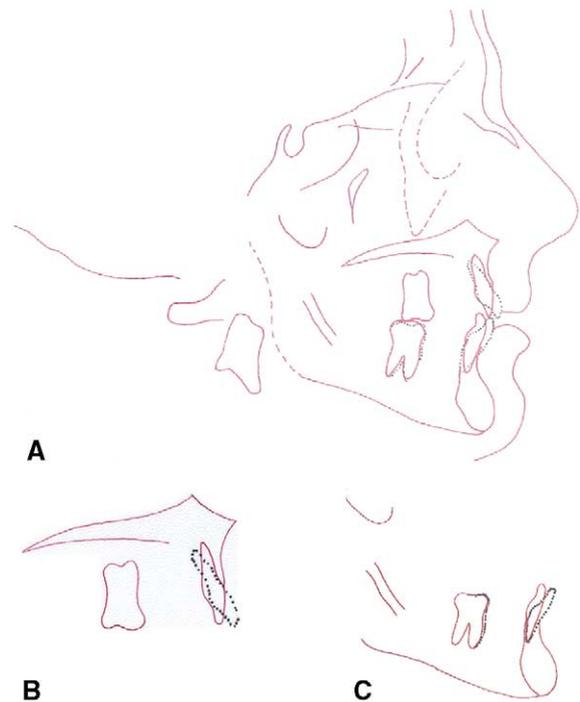


Fig 9. Pretreatment and posttreatment superimpositions: A, Anterior cranial base; B, maxillary; C, mandibular.

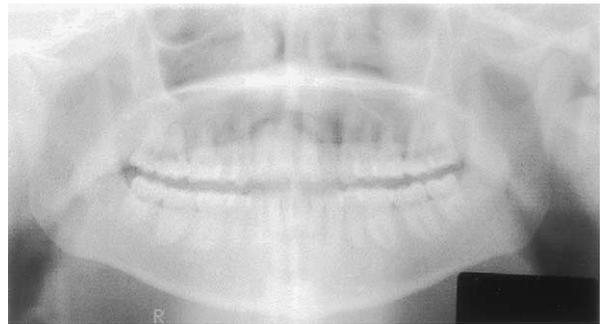


Fig 10. Posttreatment panoramic radiograph.

could have been better. However, this would have required extra aligners for case refinement, but the patient declined further treatment.

The pretreatment and posttreatment cephalometric analyses are given in the Table. The major changes were observed in the decreased interincisal angle, thus creating a better interincisal relationship (Figs 8 and 9, A). The overall superimposition was done on the anterior cranial base and showed that no growth occurred; this was expected (Fig 9, A). Maxillary superimposition was done by using the palatal plane (Fig 9, B). It can be seen that the molar position was main-

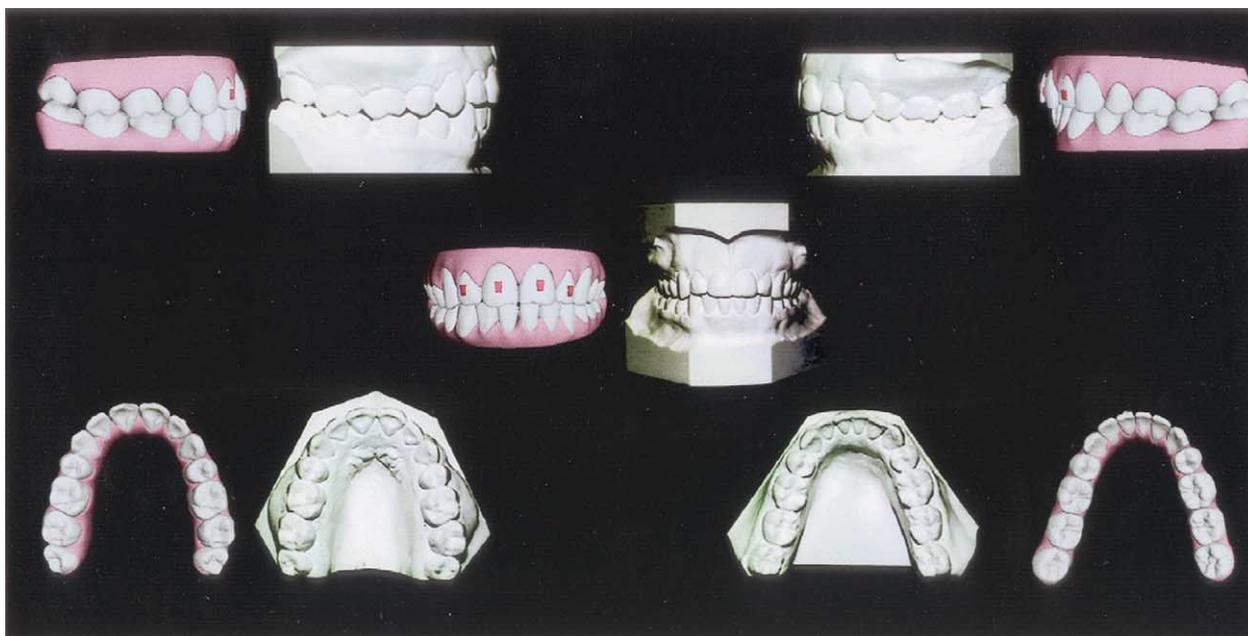


Fig 11. Comparison between final clinical and final virtual treatment.

tained as the incisors moved forward 4 mm and tipped forward 6°. Mandibular superimposition was done by using the mandibular symphysis and the mandibular canal (Fig 9, C). It showed that the mandibular incisors proclined 8° and moved forward 3 mm, while the molar position moved a little mesially. This demonstrates the decrease in the interincisal angle toward the normal. Extrusion also took place in both maxillary and mandibular incisors. However, this extrusion was not enough to obtain an ideal overbite.

The patient was extremely happy with the treatment result (Fig 6). After completing his treatment, he whitened his teeth to further display his improved smile. He is currently in retention with a retainer aligner. His periodontal status was maintained, without changes in the bone or periapical structures (Fig 10).

DISCUSSION

This case was treated with a recently introduced appliance system. The Invisalign system enables the clinician to treat different parts of the arch in different sequences. In this case, the posterior segments were expanded first, and then the anterior teeth were proclined to alleviate the crowding. We maintained the crowded teeth, while space required for alignment was being provided. The anteroposterior relationship was maintained while the transverse relationship was corrected. Moreover, the maxillary incisors were leveled,

and the overbite was improved by using composite attachments. Attachments increased the control of the movements and facilitated tooth movement in the direction desired. The final result closely matched the ClinCheck predictions for each arch (Fig 11).

Patient education can be used as a motivating stimulus that might predict patient acceptance of the appliance and increase compliance.³ This patient's interaction with his orthodontist greatly contributed to the success of this case. He viewed ClinCheck and was told the direction of the tooth movement. He paid close attention to the fit of his aligners and the progress of his treatment. This was a good example of how ClinCheck can be used as an educational tool to show the patient the final treatment objectives.

Although the result markedly improved the patient's smile and addressed his chief complaint, it also presented some problems. The anterior open bite was not finished to ideal position. Expansion could have partially contributed to opening the bite.⁸ Furthermore, maxillary incisor position finished in a superior position compared with the canines and the posterior teeth. This might be due to proclination in the anterior and expansion in the posterior areas. Although the superimpositions demonstrate extrusion in the incisor area, this was not enough to achieve an ideal overbite. Considering this, the overbite achieved was reasonable. In addition, mandibular incisor alignment was not completed because of a delay between the appliance and the virtual

treatment. Slight overcorrections to recapture the necessary tooth movement were recommended.⁴ However, the patient was happy with his result and did not desire to prolong treatment. It is now recommended that slight overcorrections be performed in ClinCheck to anticipate these necessary additional tooth movements.

CONCLUSIONS

This article discusses a crowding case treated with Invisalign, a hygienic, removable, and comfortable appliance. With this appliance, the arches were expanded, and the crowding was corrected without reproximation. The treatment progressed with no problems. Other treatment alternatives were considered, but each had disadvantages. Fixed appliances offer better control of treatment but carry the concern for esthetics and hygiene for an adult patient. The spring retainer had the advantage of being removable, but it posed several shortcomings, including addressing only the anterior teeth, and no modifications of arch width; it would not be feasible to level the arch with a spring retainer, and a considerable amount of reproximation to completely correct the crowding would be required. Invisalign presents a unique mode of treatment for adult orthodontic patients. It removes their esthetic, hygienic, and metal-allergy concerns. It also allows treatment to finish in about the same amount of time as fixed appliances.

The Invisalign system does have some limitations. Currently, severe derotations, complex extrusions, and large translations are less predictable with Invisalign alone and might require auxiliary treatment. Although Invisalign's laboratory fees are higher than conven-

tional appliances, the virtual setup, ease of treatment, and patient acceptance might compensate for the extra cost. This setup is not only a diagnostic aid, but it can also be used as an educational tool for the patient. In addition, patient cooperation is imperative for the success of the treatment. For this patient, cooperation was not an issue because he was enthusiastic about his treatment.

Considering that this appliance is in its development infancy and that this was a moderately severe crowding case, the treatment finished with good results, and the patient was pleased with the outcome.

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