Case Report

Root Resorption Following Treatment with Aligners

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ABSTRACT

Can orthodontically induced inflammatory root resorption (OIIRR) be the result of Invisalign treatment? Since OIIRR was first described in the literature, orthodontists have been looking for a treatment procedure where no root shortening will occur. In the past decade, Invisalign orthodontic treatment has become very popular, and there is no description of OIIRR after this treatment. Therefore, it might be incorrectly concluded that the body is immune to this type of orthodontic treatment modality and no OIIRR appears as a result of this treatment. The following case report demonstrates an aspect of the complexity of OIIRR.

KEY WORDS: Root resorption; Invisalign; Aligner

INTRODUCTION

A healthy male patient, age 25, was referred by his dentist to our orthodontic clinic. His chief complaint was related to the severe malalignment of the maxillary teeth, especially the incisors (Figures 1 through 5). The patient asked for a nonextraction treatment using the clear plastic treatment available. He reported that he had seen this treatment possibility—Invisalign® (Align Technology, Inc. Santa Clara, CA, USA)—in a commercial on the Internet.

DIAGNOSIS

After examination, the patient's malocclusion was summarized as follows: skeletal Class III relations with an enlarged mandible (140 mm) relative to a normal size mandible and a normal size and positioned maxilla (100 mm and SNA 80°, respectively), compensated by a clockwise rotation of the mandibular plane to SN and Frankfurt horizontal (42° and 30°, respectively). The lower facial height to total facial height ratio was 60%.

The dentition showed a bilateral dental Class III malocclusion, crossbite of the upper laterals and the left first premolars, moderate crowding in the maxillary arch, and slight crowding in the mandibular arch. The overjet and overbite were about 1 mm each. The mesial incisal edges of the two maxillary central incisors had been fractured at age 10, and the patient had been under the supervision of his dentist since then. No further complaint related to the traumatized teeth was recorded. Obviously, those traumatized teeth, as noticed, were never restored. The full mouth periapical series and panoramic and lateral chepalometric radiographs revealed normal bone, tooth, and root structures (Figures 6 through 8).

TREATMENT

The patient declined a number of treatment alternatives: extraction of one lower incisor, extraction of two mandibular second premolars, extraction of two maxillary and two mandibular premolars, and a fully comprehensive orthognathic surgical treatment. Because the patient asked for a treatment that involved nonextraction, no surgery, and no braces, his records were carefully evaluated for the Invisalign treatment technique.

The Invisalign technique uses three-dimensional (3D) computer imaging technology to depict the complete treatment plan from the initial position to the final desired position from which a series of custom-made, clear ''aligners'' are produced. Each aligner moves teeth incrementally and is worn for about 2 weeks, then replaced by the next in the series until the final position is achieved.[1]

The treatment plan was to expand the upper arch, resolve the crowding in both arches, and correct the

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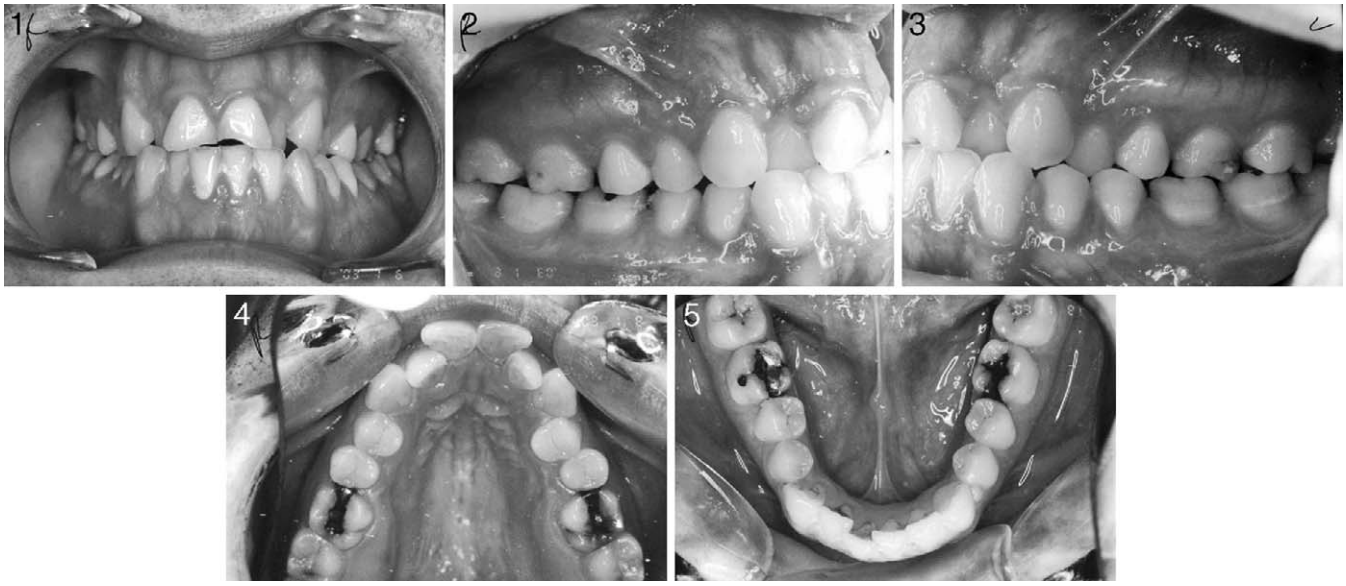


Figures 1–5. Initial intraoral photos.

crossbite. There was no attempt to correct the Class III malocclusion. This was a compromise treatment plan knowing the appliance limitations. However, the orthodontist anticipated that the patient would change his mind during the treatment and would later agree to wear braces for the finishing stages.

The patient signed a thorough informed consent, specially designed for Invisalign treatment patients, indicating that he understood the limitations of the appliance (like torque of the maxillary lateral incisors[2] and appropriate expansion) and understood that the finishing part would probably be done using a clear fixed appliance system. In addition, like all of our patients, he also signed a regular informed consent regarding the overall orthodontic treatment, which includes the risk of orthodontically induced inflammatory root resorption (OIIRR).

A polyvinylsiloxane impression of both upper and lower arches was sent to the Align Company in the United States. After several online changes, the final series of aligners (27 for the upper arch and 24 for the lower arch) were manufactured and sent to the orthodontist along with special instructions for attachments and inter-proximal reduction (IPR) (Figures 9 through 11).

PROGRESS AND RESULTS

The patient wore the aligners as instructed and did not miss any scheduled appointments. He visited the office once a month, or every 6 weeks, where the orthodontist examined him according to the instructions given by the Align Company. The IPR was done in time, and all collisions (a special term used by Invisalign mentors to describe contacts between neighboring teeth that prevent the desired movement because of friction) were removed accordingly. Fourteen months later, the patient completed wearing the series of the aligners.

Because the malocclusion was not fully resolved, as it was planned in the online ClinCheck, the patient was

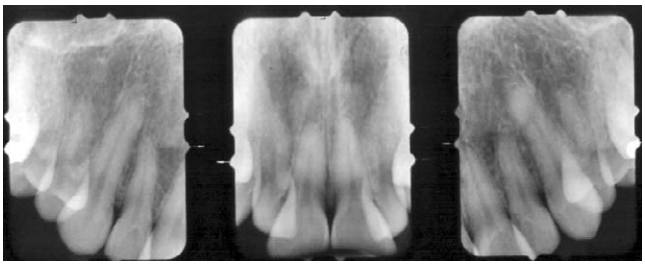


Figure 6. Initial periapical radiograph.

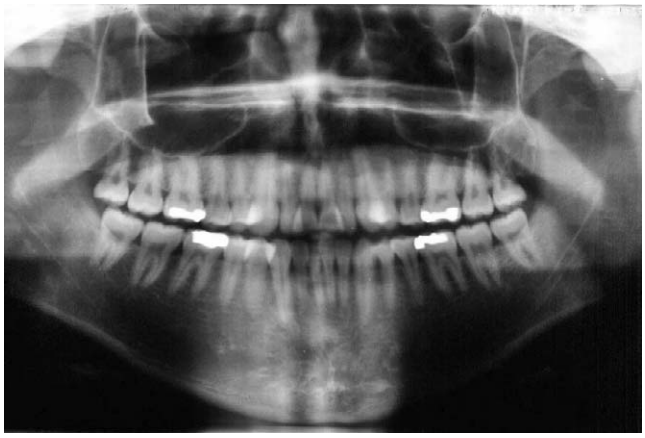


Figure 7. Initial panoramic radiograph.

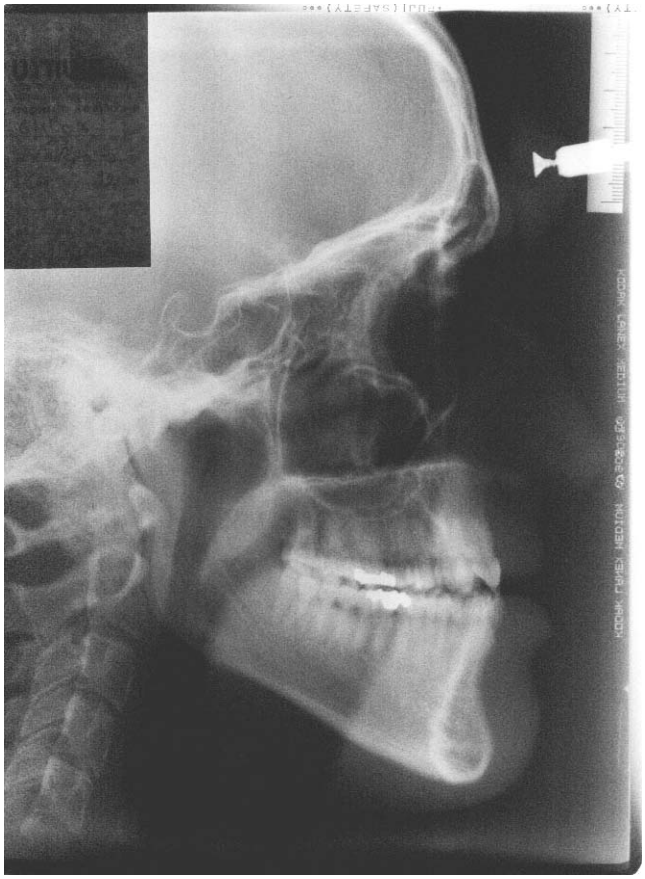
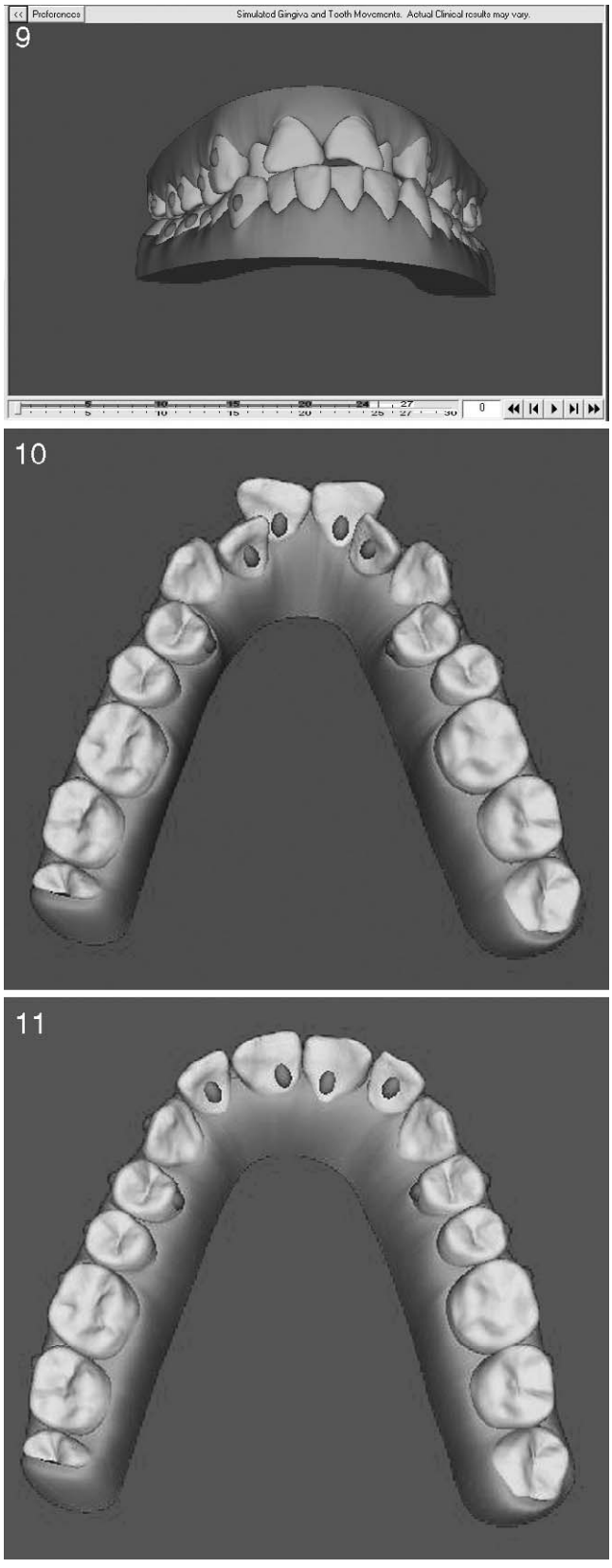


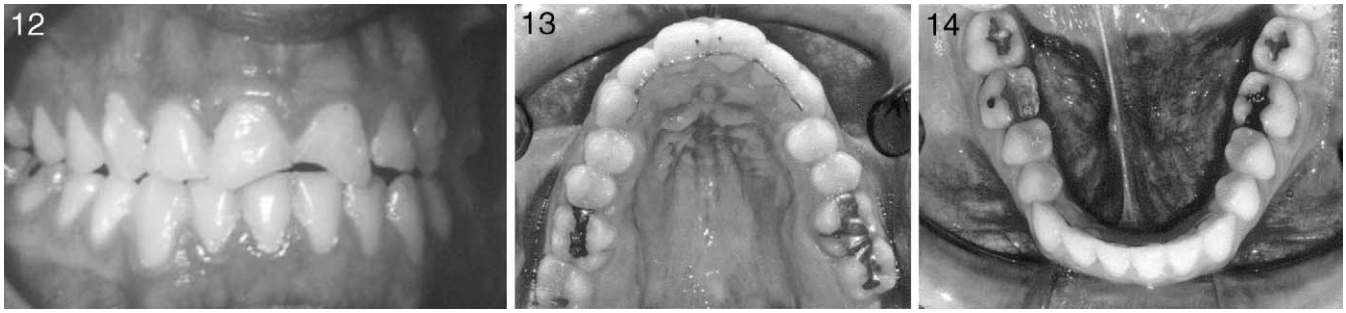
Figure 8. Initial lateral head film.

offered the opportunity to continue the treatment by refinement aligners (ClinCheck is the Align Technology proprietary software that illustrates the movement of teeth as determined by the precise treatment instructions of a treating doctor. Using a 3D virtual treatment plan, ClinCheck demonstrates the planned progress of treatment and the number of aligners to be used to achieve the final result). Refinement aligners are a series of aligners that can be added at the end of the scheduled treatment procedure to finish off any tooth movement not fully expressed by the original series of aligners. However, the patient was very happy with the results and was reluctant to undergo any further refinement or tooth movements by fixed or removable appliances. It is imperative to add that during treatment no fixed appliance therapy was involved (eg, no brackets, no buttons, no elastics, no power arms). A fixed retainer was bonded from canine to canine in both arches (Orthoflex Tech, Reliance Orthodontics Products, Itasca, Ill), and the patient was sent for final records (Figures 12 through 14).

In the periapical, panoramic, and cephalometric radiographs (Figures 15 through 17) one can clearly see the root shortening of the four upper incisors. This involved root resorption apically, from 2 mm to one third



Figures 9–11. Stages in the ClinCheck.



Figures 12–14. Final intraoral photographs.

of the original root length.[3] The patient was informed about the event and was sent later to his dentist to restore the fractured upper central incisors (Figure 18).

DISCUSSION

The objective of this report is to present the case of a patient who experienced severe[3] root resorption during treatment with aligners. The purpose of this paper is not to discuss the quality of the finished orthodontic results that is clearly, by all means, not acceptable. It is obvious that a posterior malocclusion is still present, and that the teeth are not well aligned in both arches. This report presents neither the skill of the individual nor the potential of the overall Invisalign technique in orthodontic treatment by aligners.

Recently, a longitudinal study of 100 consecutive Invisalign patients was published that showed no measurable root resorption. In contrast, an average 10% of patients treated with fixed appliances have clinically significant root resorption of at least 3 mm.[4]

In their comprehensive review, Brezniak and Wasserstein[5] claimed that orthodontics is the only dental profession that uses the inflammation process to solve esthetic and functional problems. Force application on the teeth with any appliance, fixed or removable, initiates a sequential cellular process. We know exactly how and when it is evoked, but we are unable to predict its actual overall outcome. The extent of this inflammatory process depends on many factors, such as the virulence or aggressiveness of the different resorbing cells as well as the vulnerability and sensitivity of the tissues involved.

The Invisalign treatment technique belongs to the category of removable appliance treatment modalities. It applies intermittent forces to the teeth just as do most active removable appliances. Several publications address the point that the pause in treatment with intermittent force allows the resorbed cementum to heal and prevent further resorption.[6,7] On the other hand, intermittent forces have been linked in their effects to detrimental jiggling forces.[8] There is no difference whether the force is applied from a regular removable appliance like a Hawley appliance with springs or screws, or another removable appliance such as aligners.

Unfortunately, the force levels produced by the Invisalign treatment technique have not been published. It can be only assumed that since each aligner is designed to move the teeth up to 0.2 mm, the force levels the teeth experienced are in the lower range of the orthodontic force levels. However, even this parameter, meaning the difference in force levels heavy or light, was not proven to be a factor in OIIRR.[9,10] We experience OIIRR using all levels of orthodontic forces.

It might be concluded that the vulnerability of the patient described here, along with the aggressiveness of the resorption process, brought him to the new con-

Figure 15. Final periapical radiograph.

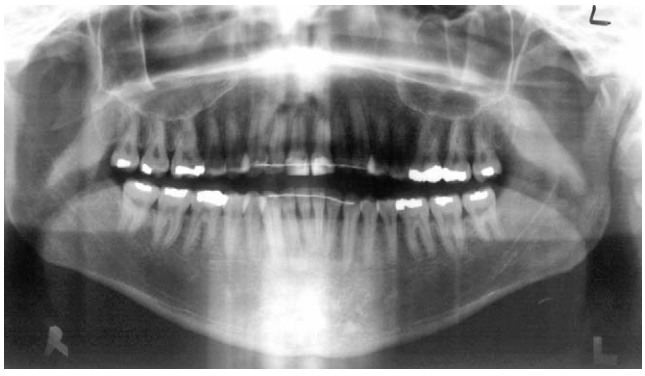


Figure 16. Final panoramic radiograph.

Figure 17. Final lateral head film.

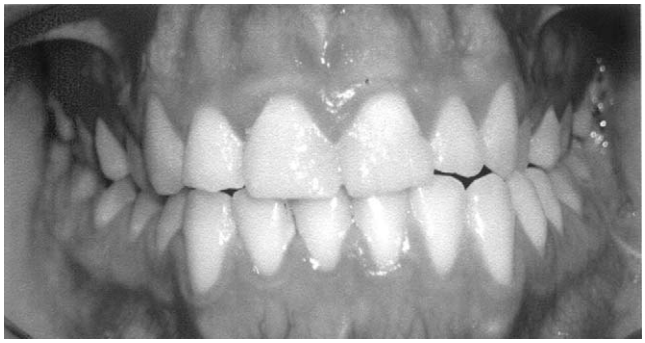


Figure 18. Frontal intraoral photo after the cosmetic restorations.

dition where the roots of his four upper incisors were severely shortened. It does not mean of course that he is going to lose those teeth soon.[11] Further, individual variations, susceptibility, and familiar disposition, which are related to this process, remain beyond our current understanding.[7] They can come into expression using very light, light, heavy, or heavier forces.[9,10] We are therefore unable to predict the incidence and extent of OIIRR after any force application, be it from fixed or removable appliances. Because the Invisalign treatment technique is done by force application on the teeth, this treatment modality cannot be excluded.

We know that the patient experienced trauma to his 2 maxillary central incisors when he was 10 years old, 15 years before the orthodontic treatment. The scar of, fracture of the mesial incisal surfaces of both teeth, was not restored before the orthodontic treatment. We know that traumatized teeth can exhibit external root resorption without any orthodontic treatment[14] and orthodontically moved traumatized teeth with previous root resorption are more sensitive to further loss of root material.[12–15] The average root loss for trauma patients after orthodontic therapy was 1.07 mm compared with 0.64 mm for nontraumatized teeth.[15] However, another article suggested that traumatized teeth without signs of resorption are not resorbed more than nontraumatized teeth.[16] All those publications refer to orthodontic treatment of children several years after the trauma.

When trying to analyze these publications and the OIIRR this patient experienced, we cannot conclude that the previous trauma was responsible for the root shortening to the four teeth. First, the previous trauma might perhaps explain the OIIRR event of only the two maxillary central incisors, but not the root shortening of the two maxillary lateral incisors, which were not harmed by the earlier injury because they were located far behind the traumatized teeth in a crossbite position. Second, no sign of pretreatment root shortening of the four maxillary incisors was visible on any of the radiographs that were part of the initial records. Third, the amount of the resorption as is seen in the radiographs is much larger then the average published for previously traumatized teeth.[15]

Orthodontics uses the inflammation process to move teeth. Force application, even by the Invisalign technique, initiates sequential cellular processes, as do all other orthodontic appliances that might lead to root resorption. Consequently, we were not surprised to see this OIIRR phenomenon in an Invisalign patient. We hope that in the future, the preference of the Invisalign treatment modality versus another treatment modality will not be related to the OIIRR phenomenon, because as far as we understand OIIRR can result from all treatment procedures. Unfortunately, we do not know yet of an orthodontic treatment that can prevent OIIRR.

CONCLUSION

The significance of this publication is the description of the OIIRR phenomenon in a patient treated by the Invisalign technique. Although it reports only one anecdotal case of a patient who unfortunately experienced severe root shortening during treatment, we suppose that the OIIRR phenomena can unpredictably appear with this treatment modality, just as it does with all other orthodontic treatment modalities.

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