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# Efficiency of Invisalign in Contemporary Orthodontic Practice

**Abstract:** The demand for clear aligners continues to grow. Their use is no longer exclusive to adults, because aligners are also now popular among younger patients as well. In the literature, there is an emphasis on cases of mild to moderate severity, which have usually been treated on a non-extraction basis, perhaps owing to the difficulty in managing space closure or a challenging tooth movement, such as derotation. The article highlights appropriate case selection in clinical orthodontic practice, and the key role that Invisalign plays.

**CPD/Clinical Relevance:** The reader should appreciate the potential of the Invisalign system in managing certain scenarios commonly encountered in clinical orthodontics practice.

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Innovation in 3D printing and customization, and the evolution of digital dentistry has led to the development of many clear aligner systems in the last couple of decades. The Invisalign system was originally introduced in 1997 and was subsequently made available to providers in 1999, by Align Technology.<sup>1</sup> This has dramatically changed the way we align teeth in an ever-increasing number of cases by providing a comfortable, removable, and almost invisible alternative to conventional fixed orthodontic appliances. Treatment consists of a series of clear aligners that gradually move teeth by carefully planned incremental movements into the desired correct position. This convenience and patient acceptability has led to this method of tooth movement increasingly being the primary treatment of choice for many adults and young patients in modern clinical orthodontic practice.

Although originally prescribed only for the management of mild malocclusions, the efficiency of the Invisalign approach and its clinical potency still remains a controversial

point for discussion among treatment providers. The most recent evidence,<sup>2</sup> suggests that Invisalign treatment can only be recommended for non-extraction treatment in mild to moderate crowding, among young growing patients. In contrast, it is claimed that aligners have limited efficacy and poor outcome when it comes to closing extraction spaces and/or treating adult patients.<sup>3</sup>

The aim of this report is to demonstrate and illustrate the potential for the Invisalign system to be effective in severe crowding cases in young growing patients. In addition, the article highlights appropriate case selection in clinical orthodontic practice.

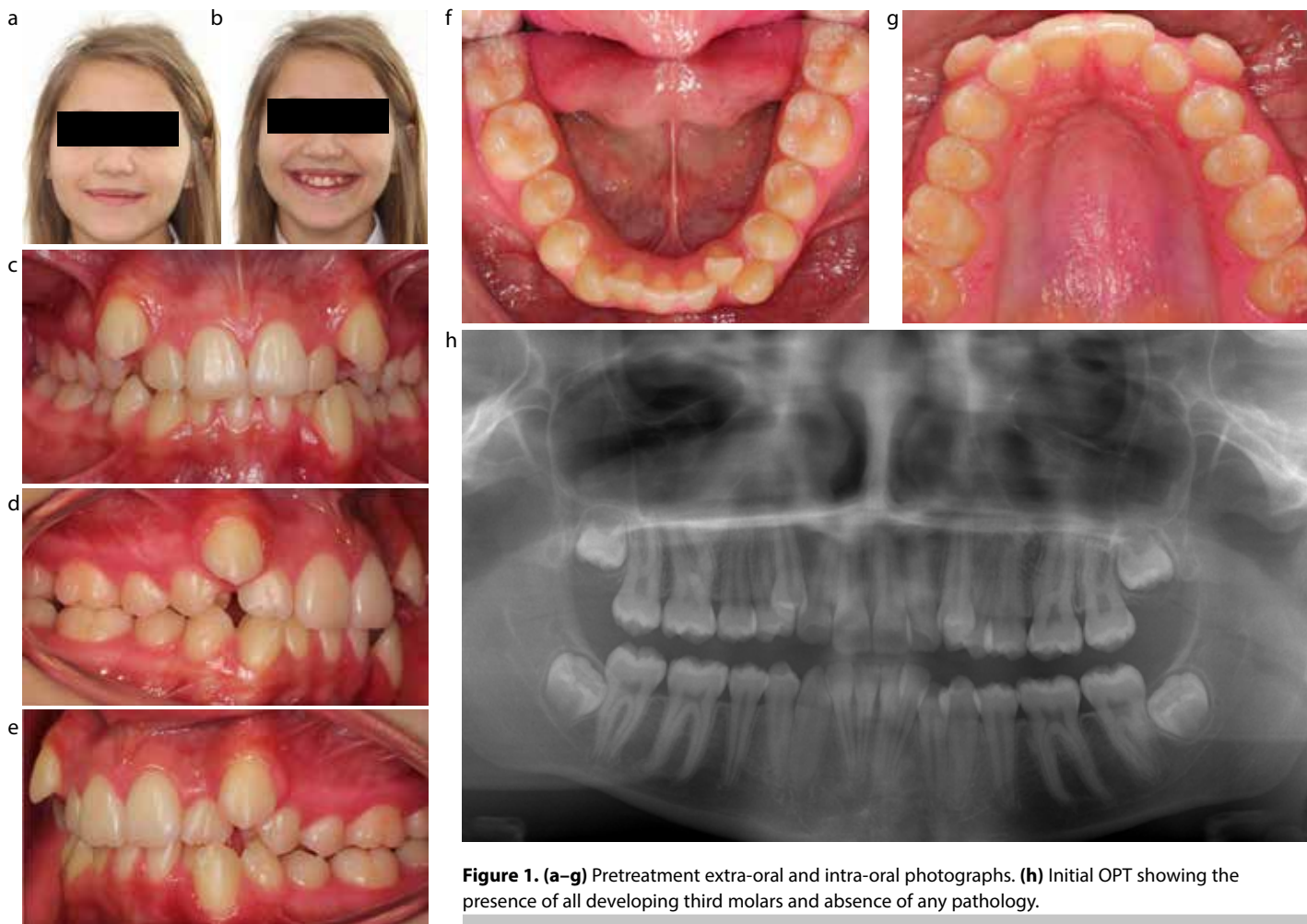
While the first case report describes a young crowded patient treated with Invisalign aligners involving the removal of four premolar teeth, the second describes the orthodontic treatment of an adult patient who, because of a diagnosis of multiple sclerosis (MS), felt she would be unable to cope with the demands placed on her if fixed appliances had been used.

## Case 1

### Diagnosis and treatment planning

A 14-year-old female presented in the permanent dentition with severe upper arch and moderate lower arch crowding. She presented with a Class I molar relationship, labially blocked out canines in the upper arch, and an anterior crossbite. The incisor classification was Class I, and the canine classification was half a unit Class II. She presented with a symmetrical face with an average lip line, an average nasiolabial angle, a Class I profile and an average Frankfort-mandibular planes angle. Cephalometric analysis revealed a Class I skeletal relationship. In addition, the panoramic X-ray confirmed the presence of the remaining permanent dentition (Figure 1).

The patient expressed a concern about the appearance of her anterior teeth, but also expressed severe misgivings about the poor aesthetics associated with the labial fixed orthodontic appliances. Space analysis deemed extractions of the first premolars necessary. To address the patient's concerns



**Figure 1.** (a–g) Pretreatment extra-oral and intra-oral photographs. (h) Initial OPT showing the presence of all developing third molars and absence of any pathology.

about aesthetics we employed the Invisalign system. The ClinCheck suggested the type and position of attachments. Optimized root control attachments, were used on the premolars and molars, these were used with SmartStage Technology (Align Technology Inc, CA, USA) to control root movement. Moreover, optimized multiplane attachments, were used on the lateral incisors to control rotation and vertical movement. This type of attachment also allowed control of the teeth adjacent to the extraction spaces (Figure 2). The patient and parents consented to the treatment and committed to achieving and maintaining exemplary standards of oral hygiene.

**Treatment progress and results**

The patient’s motivation and compliance with wearing the aligners and elastics was excellent. Aligner fit was checked every 6–8 weeks, and to ensure positive connection between the ‘bumps’ on the teeth and ‘bubbles’ in the aligners, the patient inserted and removed the new aligners during each appointment. Alignment and space closure was achieved gradually



**Figure 2.** (a) Upper and lower first premolars extracted and attachments bonded as per the Invisalign ClinCheck. (b) Upper and lower clear aligners in place.



**Figure 3.** Class II elastics are used to reinforce intermaxillary anchorage and refine the canines position.



**Figure 4.** Triangular elastics with a vertical element are used to refine the occlusion and facilitate interdigitation.



**Figure 5.** (a–e) End of treatment intra-oral photographs. (f) End of treatment smiling extra-oral photograph.

with sequential aligners. Initially, closure of extraction spaces started by moving the canines distally. Canine retraction and alignment was achieved through the aligner and retraction attachment force system. To attempt to supplement anchorage during space closure, Class II elastics (1.6–2.6 oz) were used (Figure 3). Initially, the Class II elastics were extended from the lower second molars to precision cuts accommodated on the canines; however, this was felt to contribute to the loss of tracking, so subsequently, a power arm, custom bent in 21' x 25' TMA, was bonded to both upper canines, and the Class II traction was then used to help seat the canines into the aligners.

At the finishing stage, buttons were attached to the buccal aspect of the lower canines and second premolars, and triangular elastics with a vertical element were prescribed to refine the occlusion and facilitate settling (3.6–4.0 oz) (Figure 4). Improvement was noted in the occlusion

and interdigitation. The patient's chief complaint of prominent unaesthetic, crowded canines was addressed over a period of 22 months (Figure 5). A Class I molar and incisor relationship was maintained, and a Class I canine relationship was achieved with an initial series of 24 aligners and a refinement series of a further 14 aligners.

#### Discussion

The demand for clear aligners is burgeoning among adults, primarily because of their aesthetic appearance. Currently, this approach is no longer exclusive to adults, because aligners also appeal to younger patients. In the literature, there is an emphasis on cases of mild to moderate severity,<sup>4</sup> which have usually been treated on a non-extraction basis, perhaps, owing to the difficulty of both closing extraction spaces and correcting root angulation with aligners. In the case presented, premolar extractions were

prescribed and spaces were successfully closed, and anchorage was managed efficiently. Although premolar derotation had been programmed in the ClinCheck set-up, this movement is notoriously challenging with aligners and may require the use of auxiliary orthodontic devices to achieve this predictably.<sup>5</sup> Perhaps with hindsight, LL5 might have been better suited for extraction rather than the LL4. In addition, delivering effective Class II traction in aligner cases can be problematic when delivered to precision cuts in the upper aligners. The reason for this is that elastic traction actually pulls the upper aligner away from the upper teeth that can therefore lead to a loss of tracking, which was experienced in this case. Far preferable is to bend up an auxiliary wire to accept the Class II traction and actually bond it to canine teeth. This will have the effect of delivering a Class II force and pull the canines into the aligner rather than vice versa. This case therefore demonstrates that premolar extraction cases, when the teeth extracted are close to the site of crowding, can deliver a good outcome in a reasonable time frame. In the future, as experience of aligners in extraction cases grows, there is likely to be more use of clear aligners in significantly more complex orthodontic cases with improved outcome. In the present case, the successful use of intermaxillary Class II elastics with aligners, enabled resolution of the malocclusion and promoted achievement of a Class I relationship within 2 years.

## Case 2

### Diagnosis and treatment planning

A 40-year-old female attended our orthodontic department following referral by her general dental practitioner (Figure 6). Her chief complaint was the crowding in the lower labial segment. She presented with Class I incisor relationship, on a Class I skeletal base with average vertical proportions, complicated by a moderately crowded lower arch and mildly crowded upper arch. The molar relationship was Class I, and the canine classification was half a unit Class II on the left. She had a symmetrical face with a retrusive lip, and an average nasiolabial angle. The lower lip was trapped behind the UR2 and UL1. The patient had previously been diagnosed with multiple sclerosis (MS) and was in active treatment for this medical condition. MS is a chronic and progressive autoimmune disorder where there is abnormal regulation of the immune system. It is a demyelinating disease of the central nervous system, which includes the brain

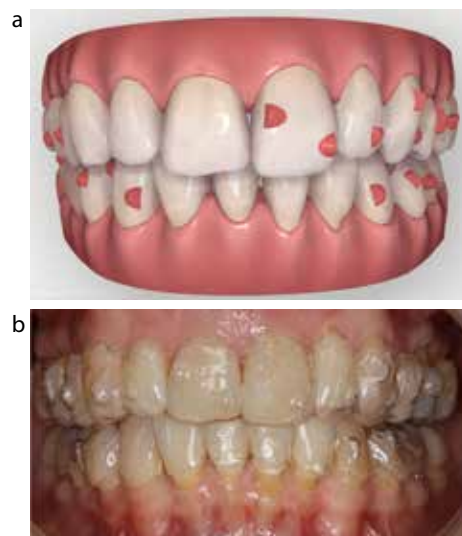


**Figure 6.** (a–h) Pre-treatment extra- and intra-oral photographs.

and the spinal cord.<sup>6</sup> The exact cause of MS is unknown, but it is linked to both genetic and environmental risk factors. Genetic risk factors include being female and having genes that encode a specific type of immune molecule (HLA-DR2), which is used to identify and bind foreign molecules. Environmental risk factors include infections and vitamin D deficiency. Together these

genetic and environmental influences might lead to the body not removing immune cells that target myelin.<sup>7,8</sup>

She had considered having orthodontic treatment for a couple of years, but following her own personal research, she informed us that she would not have the manual dexterity to manage the meticulous oral hygiene demands placed on her



**Figure 7.** (a) Invisalign ClinCheck projection showing type and position of attachments. (b) Attachments bonded as per the Invisalign ClinCheck.

with conventional fixed appliances. She requested that the Invisalign appliances were used to correct her malocclusion.

Treatment objectives were to:

- Improve oral hygiene to a standard that she would be able to maintain;
- Align the upper and lower arches;
- Maintain Class I incisor, Class I molar, and achieve Class I canine relationships.

Following consultation with the patient's neurologist, we decided to proceed with treatment. Treatment objectives were achieved using the Invisalign system (Figure 7a). The ClinCheck showed the type and position of attachments and a series of 15 clear aligners was designed and fabricated to treat the case (Figure 7b). The patient was instructed that traditionally each aligner was usually worn for 2 weeks; however, if her teeth were completely comfortable with the next aligner after 1 week or 10 days, she could go ahead and change her aligners. She was asked to record how often she replaced her aligners. Aligner fit was checked every 6 weeks to ensure there was no loss of tracking. After the initial 5 months, the patient had reached her 15th and final aligner, because she felt completely comfortable changing them after either 8 or 9 days. A refinement was requested to correct upper contact points on the laterals and canines and a further six aligners were delivered and subsequently worn. The patient's chief complaint was successfully addressed over a 9-month period (Figure 8).

#### Discussion

The relevance of some medical conditions



**Figure 8.** (a) End of treatment smiling extra-oral photograph. (b–f) End of treatment intra-oral photographs.

to orthodontic treatment has been discussed in the literature,<sup>9</sup> which also stresses the need for a detailed medical history before embarking on treatment. Consultation with the patient's general medical practitioner or specialist should always be sought, and in this case, advice from the patient's neurologist was acquired. While clear guidance for managing orthodontic patients with MS is lacking, some considerations have been suggested. A multidisciplinary approach including the patient's physician, neurologist, MS specialist, nurse and caretaker is key for a successful outcome.<sup>10</sup> Using an electric toothbrush can help also compensate for the loss of manual dexterity attributed to MS.

Some MS patients require MRI frequently; therefore, they are advised to avoid metallic brackets, because it has been shown to detrimentally affect the MRI and impair diagnosis as a result of MRI artefacts.<sup>11</sup> Sometimes, removable appliances are avoided due to the risk of seizures attributed to MS symptoms, and while clear aligners are

classified as removable appliances,<sup>12</sup> their 'snug fit' leaves them posing minimal or no risk to patients.

Consideration should also be given to any medications the patient is taking. Among these are NSAIDs, cortisone, interferon, antiepileptic drugs, and antivertigo drugs. Because NSAIDs and interferons have been suggested to decrease the rate of tooth movement during orthodontic treatment,<sup>13</sup> this should be borne in mind when discussing with the patient how often they should change their aligners, and when assessing the progress of the case.

### Conclusion

This article has presented two cases that illustrate how clear aligners can provide a viable alternative to the 'gold standard' fixed appliances.

Case selection is of paramount importance when it comes to the use of any orthodontic appliance system, and the Invisalign system can be suited to treat

orthodontic cases involving extractions and to provide an alternative to patients with complex medical problems who just want a simple but aesthetic approach.

### Compliance with Ethical Standards

**Conflict of Interest:** The authors declare that they have no conflict of interest.

**Informed Consent:** Informed consent was obtained from all individual participants included in the article.

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