

TRABAJO DE FIN DE GRADO

Grado en Odontología

**INVISALIGN TREATMENT
IN
GROWING PATIENTS**

Madrid, curso 2020/2021

Número identificativo

217

SUMMARY

Objectives: To study the use of Invisalign in growing patients and develop its different systems (Invisalign First and Invisalign Teen), compare those systems with fixed orthodontic appliances, analyze the most appropriate time of treatment and investigate the recent incorporations in Invisalign.

Material and methods: A bibliographic research is carried out through the investigation of numerous databases: Biblioteca CRAI Dulce Chacón, Pubmed, Medline and Research Gate. 41 articles were selected based on pertinent key words such as aligners and growing, and care has been given to meet the inclusion criteria as the selection of studies describing only the use of Invisalign Teen.

Discussion of the results: 17 studies were included. 8 studies related to the comparative with fixed orthodontic appliances were organized in categories regarding periodontal health, salivary levels of cariogenic bacteria, speech articulation, outcome and duration. Invisalign showed better results in the 2 first categories, as well as for treatment duration. However, speech impairment and movements limitations have been noted. 9 studies were related to the most appropriate time of treatment and divided regarding sagittal, transverse and vertical anomalies. All of them showed the best results for early treatment.

Conclusion: Those two systems present multiples interests in the field of orthodontics. When compared to the traditional fixed orthodontic appliances, it appears that both possess advantages and disadvantages which lead to perform individual treatment plan to each patient. As for the good treatment timing, all studies met the same conclusion regarding

early management. Finally, recent incorporations in Invisalign reflects a continuous research, enlarging the field to more complex malocclusions.

RESUMEN

Objetivos: Estudiar el uso de Invisalign en pacientes en crecimiento y desarrollar sus diferentes sistemas (Invisalign First e Invisalign Teen), comparar esos sistemas con aparatos de ortodoncia fijos, analizar el momento más adecuado de tratamiento e investigar las recientes incorporaciones en Invisalign.

Material y métodos: Se realiza una búsqueda bibliográfica a través de la investigación de numerosas bases de datos: Biblioteca CRAI Dulce Chacón, Pubmed, Medline y Research Gate. Se seleccionaron 41 artículos en base a palabras clave pertinentes como alineadores y crecimiento, y se ha prestado atención para cumplir con los criterios de inclusión como la selección de estudios que describen solo el uso de Invisalign Teen.

Discusión de los resultados: se incluyeron 17 estudios. Se organizaron 8 estudios relacionados con la comparativa con aparatos de ortodoncia fijos en categorías de salud periodontal, niveles salivales de bacterias cariogénicas, articulación del habla, resultado y duración. Invisalign mostró mejores resultados en las 2 primeras categorías, así como en la duración del tratamiento. Sin embargo, se han observado alteraciones del habla y limitaciones de los movimientos. 9 estudios se relacionaron con el momento más adecuado de tratamiento y se dividieron en cuanto a anomalías sagitales, transversales y verticales. Todos mostraron los mejores resultados para el tratamiento temprano.

Conclusión: Estos dos sistemas presentan múltiples intereses en el campo de la ortodoncia. Cuando se compara con los aparatos de ortodoncia fijos tradicionales, parece que ambos poseen ventajas y desventajas que llevan a realizar un plan de tratamiento individual para cada paciente. En cuanto al buen momento del tratamiento, todos los estudios llegaron a la

misma conclusión con respecto al tratamiento temprano. Finalmente, las incorporaciones recientes en Invisalign reflejan una investigación continua, ampliando el campo a maloclusiones más complejas.

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INTRODUCTION

1. Invisalign system

1.1 History of Invisalign

In 1945, Kesling was the first to offer a vacuum-formed tooth positioning appliance, usually intended for contention, to move teeth. At the end of the fixed orthodontic treatment, if minimal finishing is required, a set-up is carried out to make a positioner: the teeth are sawn on the plaster model, then moved in the desired position with wax. This positioner allows a slight dental displacement then serves as a retainer. He offered this option for minor tooth movements. Finally, the amount of work required to accomplish the task on a large scale, especially for the correction of more intricate malocclusions, hindered the realization of his project (1).

In 1997, a “new” concept was devised by two students at Stanford University: Zia Chishti, student in economics and an adult orthodontic patient himself at that time, and Kelsey Wirth. They founded Align Technology with three other persons in a small duplex in Redwood city. Chishti, who was struggling with the inconvenience of his treatment, realized that retainers-like appliances could potentially be used for the entirety of the treatment process, an option that may prove more convenient than traditional orthodontic braces (2).

They conducted intensive research in CAD modeling, using advanced computer imaging to craft a new type of orthodontic retainer. They developed the world's first mass-produced,

personalized clear aligner device by adding three-dimensional (3D) digital imaging graphics to the field of orthodontics. This modern technique revolutionized dentistry and orthodontics' world, propelling it into the twenty-first century. (1).

Align technology is currently based in Santa-Clara, California. The system received the FDA accreditation (Food and Drugs Administration), after validation of its clinical and therapeutic interest, for the American market launch in 1998 then was first presented at the AAO (American Association of Orthodontists) Congress in San Diego in 1999. By 2001, Align had manufactured one million unique aligners, help treat hundreds of patients and trained over ten thousand doctors (3). This year marks as well its arrival in Europe.

1.2 Clear Aligners

1.2.1 Type of polymer used

The type of structure obtained by the polymerization of monomers influences the behavior of plastics.

There are many criteria for the material used in orthodontics: flexible and resilient plastic with excellent shaping qualities, nontoxic, inert and unalterable in saliva, odorless and finally, tasteless and resistant to daily cleaning detergents.

At low activation levels, the type of material used influences the value of force delivered. The physical and chemical properties of materials are at the origin of the differences in results (4).

1.2.2 Thickness of the material

Various studies have been carried out on the influence of the thickness of the aligner. Regardless of the material used, the thickness of the aligner influences the value of the forces

delivered to the tooth. The greater the thickness of the aligner, the more forces it will transmit (5).

1.2.3 Thermoforming mode

During thermoforming, residual pressure can be introduced into the polymer. Therefore, regardless of the type, the thermoforming manufacturing process can cause a change in the force generated by affecting the accuracy of the fit. The device upgrade effect occurs only at high activation levels (5).

1.2.4 Activation time

After a certain time of use, the material loses its initial activation, exerting less force on the tooth to be moved. When the patient has to change aligner and remove the previous one, it has been submitted to modifications. Those modifications depend on the wearing time but as well on the rest time. Only a part of its original shape will be recovered (4).

For the recommended time of use of the aligner, which is approximately 2 weeks, there is no effect on the performance of the polymer. On the other hand, the repeated load associated with the insertion / disinsertion of the aligner results in a reduction in the transmitted force (5).

1.3 Marketing

The marketing of Invisalign is extremely powerful since the brand imposed itself in the whole world with more than 3 millions of persons treated in 10 years.

Invisalign's commercial approach is addressed to doctors but also directly to patients, via advertising (flyers, publicity page in magazines...) or even social media: it seems that a higher proportion of patients accessed information via these channels. In a lower percentage, patients got informed via the doctor himself or from their surrounding and finally a small proportion from the office marketing (6).

Nowadays, we know an increased access to social media and websites from both patients and professionals, which benefits for the latest as an effective marketing and communication tool for the practice (7).

1.4 Invisalign « First » & Invisalign « Teen »

1.4.1 Invisalign « First »

The age limit for the start of treatment with aligners in children is constantly being reduced but seems to be imposed by the appearance of the first permanent teeth: the permanent incisors and first molars (8).

Invisalign propose a "comprehensive package" for Invisalign First with as many aligners as needed to achieve the clinical goal. It aims to treat the mixed dentition by helping the development of the arch shape and the maintenance of space for erupting teeth.

Its objectives are: arch development, expansion, crowding/spacing, dental protrusions or interference corrections and cosmetic alignment (9).

On their sides, at the level of the first upper molars, they possess a blue indicator. Those indicators aim to control the diligence wearing the aligners via a color variation resulting from the duration of exposition to the saliva and fade if they are worn 22 hours on 24 (9).

1.4.2 Invisalign « Teen »

Since its development in 2015, Invisalign Teen is based on the same concept than the classical version but presents new functions specifically designed for adolescents. Among these, we can find blue color indicators, that we find in Invisalign First (described in the corresponding section). Invisalign Teen allows to anticipate and modify the aligners in the event of new permanent teeth eruption as well. The existence of eruption guidance pontics and eruption tabs takes account of the potential eruption of the last permanent teeth and allows treatment to begin in the mixed dentition (10). Finally, in case of loss or breakage, a replacement of six aligners is proposed for free.

Those two systems will be developed in the discussion as they represent the main objective of this work.

1.4.3 Comparative with fixed orthodontic appliances (FOA)

This comparison can be developed through the following points: the information transmission between the device and the tooth, leveling and friction, efficiency of the treatment, periodontal health, dental health, quality of life and the decrease in the number of appointments and their duration. Along articles, they appeared as the most recurrent themes used to expose the differences between FOA and Invisalign.

This section, and those points, will be further developed in the discussion as they represent one of the secondary objectives of this work.

2. The growing patient

2.1 Growth pattern

The size and shape of the bone shift as a result of many fundamental principles: cortical drift, migration, remodeling, displacement, and Enlow's "V" theory. The nasomaxillary complex and mandible will end with variations in size and shape, as a result of these concepts of bone formation.

2.1.1 Growth of the nasomaxillary complex

The maxilla develops by intramembranous ossification. Its growth is produced by surface remodeling as well as by apposition of bone at the sutures connecting the maxilla to the cranial base and the skull. The growth of nasal cartilaginous septum, especially the vomer and the perpendicular plate of the ethmoid, drives the nasomaxillary complex in an antero-inferior direction (11). So, as the maxilla is propelled downward and forward, it undergoes remodeling of its anterior surface mainly by resorption. For what is the transverse growth it occurs mainly thanks to the midline palatal suture as well as by the process of apposition and resorption.

2.1.2 Growth of the mandible

Before birth, the mandible is made up of two non-united halves. Towards the end of the first year of life, the two halves merge at the midline. Aside from the condyle (secondary cartilage) where growth is endochondral, the entire mandible develops through intramembranous ossification and remodeling.

Most of the growth of the mandible occurs at the level of the condyle and the posterior surface of the ascending ramus. While the body of the mandible grows mainly by apposition of bone on its posterior surface, a significant amount of bone is resorbed on its anterior surface. The body of the mandible therefore grows by remodeling. The growth at the condyle is due to the cartilage covering its joint (8). The growth of the condyle head occurs in superior, posterior and lateral external direction moving the mandible in inferior and anterior direction (11). The anterior part of the mandible only undergoes remodeling with apposition at the chin and resorption just above.

2.2 Growth assessment

While a patient remains growing, treatment with orthodontic appliances can be done to change facial growth. Nonetheless, the matter in clinical orthodontics is that facial growth is a continuous phenomenon until early adulthood and therefore the growth pattern can't be predicted with accuracy.

The direction of growth and the typical rate is known, and the different skeletal relationships in sagittal, vertical and transversal planes as well. Combined, they lead to divergences in facial form, going from Class II to Class III, and transverse discrepancies (11).

A pubertal growth spurt occurs in all children with a typical growth trend. Nonetheless, there would be variations in the onset, length, velocity and volume of growth during this era (8). In an effort to predict growth, especially the timing of the spurt, it exists numerous methods of assessment, here are some of them:

- The chronological age: not valid on its own as it can exist significant variations between people of the same age
- The dental development stage: controversial as the eruptions time can vary from one individual to another, due to local or general factors.
- The radiographic measures of skeletal maturation: considered the most reliable method. We will focus on this one and more particularly the cervical vertebrae, as it can directly be observed on the lateral cephalogram.

2.2.1 Radiological skeletal assessment: cervical vertebrae

Bacetti et al. used longitudinal evidence to link the cervical vertebrae modifications to the increase in total length of the mandible. By doing so, they created a method for the assessment of pubertal growth spurt onset. By looking at the shapes of C2, C3 and C4, they described six stages linked to the peak of mandibular growth in a more or less two years range. It was concluded that the cervical stage “CS3”, which will be succeeded within a year after by the peak of mandibular growth, was the ideal to start an orthodontic treatment (12) (Annexed Table 1).

Nevertheless, there is some questioning about how this technique is reproducible, due to the complexity in recognizing the right shapes. In addition to that, it does not precise how much will be the extension of the growth.

2.2.2 Growth spurts timing

The pubertal growth peak is different between male and female and happens earlier in the latter: around 12 years old, +/- 2 years for the girls and last two years. For the boys, and around 14 years old +/- 2 years and last 3,5 years (13). This period means that here is a bigger chance of growth modification as well as faster treatment progression.

Other indicators that the spurts have passed are the menarche for the girls and the voice changes for the boys.

2.3 Anomalies of the dentofacial development (8),(14)

2.3.1 Transverse anomalies

They are observed in the frontal direction. These anomalies correspond to occlusion disorders in the vestibulo-lingual direction in the lateral sectors. The malocclusion can be symmetrical or asymmetrical, alveolar or basal, and can create a facial asymmetry or be accompanied by a lateral deviation. These anomalies result from an increase or decrease in the maxillary or mandibular transverse diameter.

Skeletal anomalies are: endognathia (the jaw base is too narrow) and exognathia (the jaw base is too wide). Dentoalveolar anomalies are: linguoversion (the alveolar processes are too oriented inward) and buccoversion (the alveolar processes are too outwardly oriented).

2.3.2 Vertical anomalies

The dentoalveolar anomalies observed in the vertical direction are open bite and deep bite.

At the incisal level, the normal overbite is of 1/3 of the lower incisor's surfaces. When this is reduced, we speak of an anterior open bite, regularly found in children who suck their thumb

or their tongue (generally associated with buccal breathing). On the other hand, when it is increased, there is an incisor deep bite.

Belonging to vertical anomalies, there is dolichocephalic and brachycephalic growth patterns. Dolichocephalic is described as an increase lower third, that becomes higher than medium and upper third, and a tendency for anterior open bite. Reversely, brachycephalic will have a decreased lower third and a tendency for deep bite.

2.3.3 Sagittal anomalies

The sagittal dimension is, in orthodontics, the reference chosen to classify anomalies. On the occlusal plane, the most widely used classification is that of Angle. It makes it possible to establish the occlusal relationships between the maxillary and mandibular arches in Maximal Intercuspatation (MIC), by studying the relationship of the first permanent molars.

According to this classification, normocclusion is represented by Class I and is defined by a mesial position of the mandibular first molar of a half-cusp relative to the maxillary first molar.

Malocclusions are therefore classified in relation to Class I:

Any distal position of the mandibular arch constitutes an Angle Class II and is divided in two divisions:

- Class II division 1: there is a buccoversion of the upper central incisors.
- Class II division 2: there is a palatoversion of the upper central incisors.

Finally, any mesial position of more than half a cusp of the mandibular arch constitutes an Angle Class III.

2.3.4 Temporary dentition

We do not really speak of Angle's class but of terminal plane. To hope to have a class I occlusion later, it is preferable to be in the presence of a straight terminal plane (or flush terminal plane) or mesial step. A terminal plane with a distal step will frequently give a class II, and a terminal plane with an exaggerated mesial step a class III.

2.3.5 Mixed dentition

The most common situation leading to a class I is the end to end with a straight terminal plane.

3. Advantages and disadvantages of Invisalign for growing patients

3.1 Advantages

- Aesthetic

The transparent aligners are discreet but can change color, in fact Invisalign's aligners are the ones which gets the more pigmented compared to other brands (15).

However, patients complain about the visibility of saliva's bubbles that can be imprisoned in the aligners, even if it doesn't last long.

- Virtual planification

Via the ClinChek, this advantage is particularly interesting for the patient, and especially the parents, to see the final result of his treatment. For the practitioner, he can receive the initial treatment simulation and modify it as desired until satisfaction. He can thus visualize each movement, each therapeutic step, or the treatment as a whole.

- Periodontal health

Aligners cover entirely the teeth and stop one millimeter away from the keratinized gingiva.

The periodontal health is preserved because they are removable, allowing the patients to maintain a proper oral hygiene (16). Moreover, they are comfortable.

- Low risk of caries and decalcification

With FOA, the appearance of decalcifications around the brackets is a frequent secondary effect, even if diminishing since the use of glass ionomer cements. Thanks to the removable characteristic and so the maintaining of a proper brushing, aligners don't present those risks (17).

- Few or no complications associated

Aligners cause few or no emergencies (compared to FOA: bracket detachment for example), few or no wounds of the mucosa because they are well adapted, few or no inflammation, no abrasion neither allergic reaction (18).

3.2 Disadvantages

- Removable

Presented as an advantage, it can also be considered an inconvenient in so far as the success of treatment depends mainly on the cooperation of the patient. It is of interest to precise that

even with FOA and elastics, the cooperation of the patient is important. The removable characteristic is as well accompanied by a risk of loss or breakage.

- Lack of control by the practitioner

Between the risk of not wearing the required time the aligners (less than 22h/24h) and the risk of losing them, control in teenagers is very important. Practitioners must start Invisalign treatment only with patients that show motivation and compliance (10).

- Cost

More than FOA. But the price depends on the duration and the corrections to be made.

OBJECTIVES

MAIN OBJECTIVE

The main objective is to study the use of Invisalign in growing patients and develop its different systems: Invisalign First (for young patients in mixed dentition) and Invisalign Teen (for adolescents).

SECONDARY OBJECTIVES

The secondary objectives of this research are:

1. To compare Invisalign systems with the fixed orthodontics appliances (metal brackets), regarding the following factors: indications, outcome and duration of treatment.
2. To analyze when is the most appropriate time to start an Invisalign treatment.
3. To investigate the more recent incorporations in Invisalign for growing patients.

METHODOLOGY

The researches were carried out via the CRAI Dulce Chacon library, Medline, Pubmed, Mendeley and ResearchGate to identify orthodontic articles that reported on the use of Invisalign treatment in growing patients. Key words used in the search included *Invisalign, aligners, growing, adolescent, teen, children, fixed orthodontic appliance, mandibular advancement feature*. On the pages of the chosen articles, the possibility to find “similar articles” were proposed and used. As this work is also focus on a brand, researches were also conducted via the websites of Invisalign, the said brand, and Align, the founding company. Only articles from 2010 to 2020 were aimed to be selected.

Inclusion criteria:

- Studies and case reports related with Invisalign Teen system.
- Comparative studies with fixed orthodontics and Invisalign as the two modalities only.

Exclusion criteria:

- Studies with patients above 18 years old only.
- Studies that were not mentioning the brand Invisalign or clear aligners.
- Studies dating back to more than 2010.

DISCUSSION OF THE RESULTS

4. Study of Invisalign First and Invisalign Teen

Invisalign possess two systems for children and teens, respectively Invisalign First and Invisalign Teen, described briefly in the introduction of this work.

4.1 Invisalign First

Invisalign First has been created to treat developing malocclusions in primary dentition to early mixed dentition by intercepting emerging conditions and so preventing their worsening overtime if left without a treatment (9). They are an alternative to traditional treatments and functional appliances, offering the esthetic of Invisalign and less chair time, which represent an important advantage for kids. Indeed, with traditional appliances, phase 1 treatments were longer because they were divided into two stages such as expansion followed by alignment. Thanks to Invisalign First, and in the context of mild to moderate cases, these two actions are carried out simultaneously, increasing as well patient and parent's satisfaction. Also, by reducing chair time, compliance increase and patient will be more prone when time will come to start a phase 2 treatment (19).

In an article wrote by Dr Gruelle (20), a list of advantages of Invisalign First has been described.

- The eruption compensation features (described in the section below), present in teens, are also available for incisors.
- SmartStage technology for a staging expansion of the dental arch, improving its efficiency and predictability.

- New optimized expansion support attachments are available and placed directly, allowing a more bodily movement during the expansion.
- New optimized retention support for short clinical crowns.
- Aligners are changed every week.

In its discussion, the doctor described as well the benefices of keeping primary canines instead of extract them like it was done in the past. They can now be used as an additional anchorage and help to ease the expansion, it also presents a more esthetic aspect due to the absence of gap, aligners are structurally stronger and less prone to breakage, and finally, avoiding extraction means also avoiding a bad experience for the kid. However, it presents some limitations like for example when extraction is indicated for permanent tooth, the space closure cannot be done with Invisalign First. To conclude, using Invisalign First allow to expand the arch while leaving space for permanent teeth to erupt quicker and in alignment with the rest of the arch but it is important to emphasize that in case of a real maxillary endognathia, the use of an expander is inevitable.

It was difficult to find literature related to Invisalign First. The articles used to describe this section were mainly coming from Invisalign and Aligntech websites, which probably have an influence regarding the veracity of the information.

4.2 Invisalign Teen

The Invisalign Teen device works on the same principle as the classic adult version and the treatment time varies depending on the difficulty of the case. These aligners must however be renewed every fifteen days (or every seven days in case of MAF or Mandibular

Advancement Feature) and visits to the practitioner are scheduled every six to ten weeks approximately, to check the progress of the treatment.

On the other hand, Invisalign Teen has distinguished itself since 2015 thanks to three functions designed specifically for adolescents, briefly described in the introduction of this work: blue indicators, eruption guidance pontics and tabs, and the free replacement of aligners. They will be more detailed below. Also, precision cuts will be described as a feature as they show some interest of use for teens. The MAF is also one of them and will be described in its own section below.

- Blue indicators

On the vestibular molar segment of aligners and encapsulated, the blue dye is released in presence of saliva reflecting the duration of wear in the mouth. It goes from dark blue to light blue and finally become clear, along the treatment (figure 1). Through research, it seems that there is two point of view regarding this compliance indicator:

On the one hand, on orthodontic websites and Invisalign included, it is recognized as useful and effective in controlling the wearing time of aligners and effectiveness of the treatment plan; if the indicator remains blue throughout the appointments, it will therefore be considered to motivate the child to better wear his aligners, within the time requested (22 on 24h). If, however, the indicator is clear but the desired dental movements are not observable, then it may be indicated to consider reviewing the treatment plan.

On the other hand, a study carried out in 2011 by Schott and Göz (21) shows the limits of this indicator. Indeed, tests have been carried out in various aqueous medium, other than the oral one, as a function of time, pH and temperature, and have shown uncertainties with regard to

its reliability as a reflection of patient compliance. Whether intended or not, changing of color can give an estimation of wear time but cannot be taken as an objective indicator.

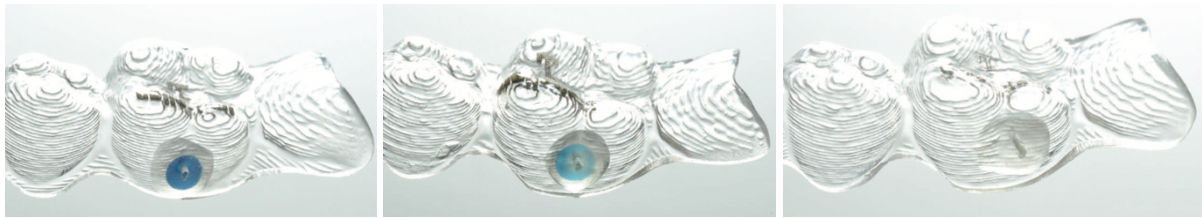


Figure 1: Blue indicator before, during and after treatment (21)

- Eruption tab and compensation

Eruption tab is a feature intended to prevent over eruption of the second molars. It covers the mesial cusp of the last molar and prevents its occlusal surface from going beyond the first molars (figure 2)(22).

Eruption compensation, that some literatures also call eruption tab or pontics, is a feature that allows the aligners to adapt to the natural eruption of the canines and second premolars during the wearing of the aligners, allowing the practitioner to prescribe the space necessary for the eruption of the teeth (figure 3).



Figure 2: Aligner with eruption tab (22)

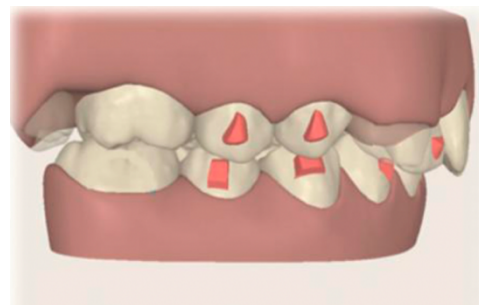


Figure 3: Clincheck with eruption compensation (22)

Those features, apart from simply helping the tooth to erupt straighter in the mouth, enable Invisalign to treat larger range of cases and helps to start treatments earlier for young patients.

- Aligners replacement

Invisalign Teen includes the replacement, for free, of six aligners in case they get misplaced or broken during the treatment (9).

- Precision cuts

Designed for elastics, they consist of a hook at the level of upper canine and another hook, or a leveling of the aligner, at the level of the first lower molar to allow the placement of a button on the latter (figure 4). The practitioner can choose their placement and type, it is flexible (23). They can be used for mild to moderate class II in the same way as MAF in teen patients, as they are growing, it can create a slight movement of the mandible forward thanks to inter-arch mechanic (24).

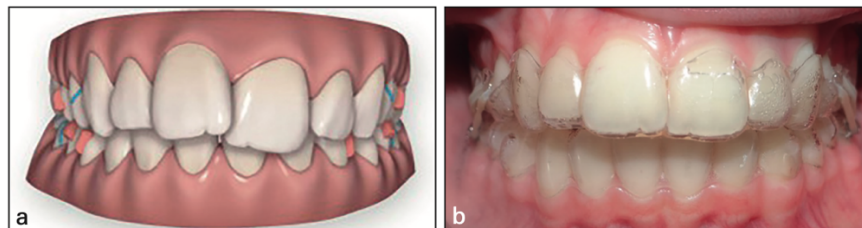


Figure 4: (a) 3D image (b) aligners and class II elastics (22)

To conclude, Invisalign First shows efficiency in expansion and beyond that, provides alignment meanwhile. Treatments are shorter, chair time as well, and it has a positive impact on the kid's experience. Regarding Invisalign Teen, its multiple features (MAF included) reflect the researches that has been made to increase the field of treatment possibilities. Finally, in a generation where esthetics has its importance, Invisalign finds its place for growing patients, with a bright future ahead.

The limitation regarding this research has been at the level of the available literature, as articles other than the ones made by dentists collaborating with Align technology, are limited in number.

5. Comparison between Invisalign and Fixed Orthodontic Appliances (Annex Table 2 & 3)

5.1 Regarding periodontal health

According to the study of Abbate et al. in 2015 (25), teenagers that were treated with Invisalign had a greater compliance with their oral hygiene, presented less plaque and gingival inflammatory reactions compared to the group treated with FOA. This study statistically demonstrated that the oral hygiene improvement was related with the type of treatment. Finally, it was brought to light the importance of a strong motivation in teenager patients, especially to avoid a failure due to insufficient wearing time.

Another study directed by Azaripour et al. in 2015 (16) confirms that the gingival health is better in Invisalign patients, due to less plaque accumulation. However, their study didn't show any difference in terms of oral hygiene improvement. It is important to precise that in this study, the patients with FOA were mainly teenagers whereas the Invisalign group were mainly adults.

5.2 Regarding salivary levels of cariogenic bacteria

In the study of Sifakakis et al. in 2018 (26), no significant differences in terms of cariogenic bacteria (*S.mutans*), between Invisalign and FOA treated patients, were exposed. On the other

hand, plaque-related bacteria (*S.sanguinis*) were significantly lower in patients treated with Invisalign. This observation confirms what the above articles regarding the periodontal health exposed: Invisalign patients have less plaque accumulation hence, less plaque-related bacteria. It is important to precise that this study is a short-term prospective study and therefore, does not reflect the results that could be obtain in the whole treatment duration.

5.3 Regarding speech articulation

In the study of Pogal-Sussman-Gandia et al. conducted in 2019 (27), it was reported that the consonants was misarticulated by patients wearing Invisalign, especially the fricative alveolar consonant /z/ and /s/. This finding is similar to that of the study of Kuyak Kayikci et al. in 2012 with the Hawley retainer plate. On the other hand, the consonant /sh/ were not impacted. This study aims to show that an impairment of speech articulation can be closely related to patient's compliance and therefore to care about, especially in teenagers.

The same year, Alajmi et al. (28) reported in their study that patients with clear aligners testified having more difficulty in their oral expression and required some changes in the way of expressing themselves.

5.4 Regarding outcome and duration

5.4.1 Duration

According to the study of Pavoni in 2011 (29), a treatment with FOA has a duration of 18 months +/- 3 months and 18 months +/- 2 months for an orthodontic treatment with Invisalign technique.

In 2014, Peter Buschang (30) searched to compare the efficiency in terms of duration between clear aligners and fixed therapy. The retrospective part of the study evaluated 150 patients wearing brackets, based on mandibular crowding, to 150 patients treated by clear aligners. All patients had class I malocclusions mild to moderate and were treated without extraction. This study determined that the necessary time of appointments for both treatments using a stopwatch.

In conclusion, Buschang demonstrated that compared to clear aligners, the FOA required many more visits (about 4), a longer treatment duration (5,5 months), more emergency visits, more chair time (93,4 minutes). However, clear aligners showed significantly higher material costs and required a total treatment time clearly longer than conventional treatment.

Finally, a 2017 study carried out by Zheng (31) on 252 patients showed that clear aligners seems to have a significant advantage with regard to the time spent on the chair and the duration of treatment in mild to moderate cases.

5.4.2 Outcome, accuracy and effectiveness

In the prospective study of Haouili et al. in 2020 (32), it was presented that the effectiveness of the aligners depends on the type of movement to be performed, the experience of the practitioner and the full cooperation of the patient. They are very effective for movements of versions, leveling, minor to moderate incisor rotations, the highest accuracy being with bucco-lingual tipping and the lowest with rotation.

Results are less predictable when it comes to closing premolar extraction spaces, torque, treating an overbite or extrusion. Nonetheless, maxillary incisor extrusion has better results than its intrusion. In this study, Invisalign's average accuracy was 50%. The strengths and limitations of tooth movement with Invisalign remained largely the same, although it has

improved since the clinical study of Kravitz et al. in 2009, realized to evaluate the efficiency of Invisalign.

To conclude, Teenagers treated with Invisalign tend to present a better compliance with oral hygiene and present less plaque retention, which makes clear aligners an interesting alternative to FOA, especially in the puberty where hormone levels tend to produce more gingival inflammation. In the same way, Invisalign should be considered as a first treatment option in high periodontal risk patients, after a careful periodontal maintenance has been ensured. Reinforcement of motivation for oral hygiene during the treatment time should not be overlooked.

Regarding the speech articulation impairment, it would represent a non-negligible factor to evaluate, when speaking about the option of Invisalign with a teenage patient. Reassurance should then be given to maintain compliance along the treatment time.

Finally, The FOA system allows for a greater number of movements, especially if the aim is to perform root movements. On the other hand, Invisalign can safely act on leveling and rotation as well as crown tipping. Treatment of moderate to severe malocclusions can be done using aligners but their fields of action are more limited than the FOA system, for which the results are more predictable. However, Invisalign provides faster treatment of mild to moderate cases without extractions, even if their accuracy in term of predictability present limitations. To overcome these limitations, new studies should be conducted and new techniques or appliances could emerge from Invisalign in the future.

6. Analyze of the most appropriate time to start a treatment (Annex

Table 4)

For this part, it has been difficult to find literature related exclusively to Invisalign. But as the objective is only interested in the good timing of age, it will be focus on this, in order to determine it.

To answer this objective, it has been decided to organize the answer following the already introduced topic “anomalies of the dentofacial development”, regarding sagittal, vertical and transverse anomalies. The ideal time to start a treatment has previously been described in terms of cervical stage of maturation in the introduction of this work, being CS3.

Only recent articles from the past 5 years have been selected.

6.1 Regarding sagittal anomalies

6.1.1 Class II malocclusion

In 2015, Suresh et al. (33) compared treatments in one or two phases in mixed dentition. The treatment in two phases is when an interceptive phase is undertaken in mixed dentition before the correction phase in young adult dentition and the treatment in one phase is when the treatment is directly started in young adult dentition. In conclusion, the authors believe that the proper diagnosis and treatment planification in mixed dentition can bring the most satisfactory results because they are helped by growth and therefore a good response to the applied forces. Soft tissues are also more adaptable giving better stability to the results. Also, the risk of traumatism of incisors decreases with an early treatment.

Oh et al. in 2017 (34) did a study to evaluate the best moment to start a treatment comparing three groups: one for early treatment, the second one for late treatment and the third as a control group. This study was not taking into account mandibular growth problem but more maxillary protrusion problem. In conclusion, the authors believe that starting the treatment of Class II in mixed dentition is an effective treatment modality allowing to reduce the number of extractions of permanent teeth.

Fleming in 2017 (35) wrote a review looking at the merits generally attributed in the literature to early treatment in the management of the main malocclusions and skeletal anomalies. Some of the elements transcribed concerning the management of Class II are that early treatment phase increases the duration of treatment and it did not show to be more effective for the overjet. However, treatment in teenagers seems to be an acceptable solution. Furthermore, Fleming quotes a Cochrane review of 2013 that showed the protective effect of an early treatment of overjet on incisors traumatism's risk.

Finally, Sabouni et al. proposed a protocol for the management of the class II by clear aligners in 2019 (24) based on three clinical cases, each of them associated to a stage of growth, based on the cervical stage of maturation. To each stage, they proposed the corresponding options of treatment.

- Before CS3, transversal anomalies correction with Invisalign First and/or expander associated.
- Between CS3 and CS4, mandibular growth stimulation with MAF or Class II elastics.
- After CS4, treatments would be more of compensation (by distalization, extractions or orthognathic surgery for more complex cases).

It was concluded that a precise evaluation of the skeletal maturation and potential of growth was essential to adopt the right protocol for each patient and their specific case.

The best time to treat skeletal class II seems to be controversial regarding treatment timing. It seems preferable to start a treatment in young adult dentition, in one phase, thus reducing the total duration of treatment. However, the early management undertaken in mixed dentition would give a better skeletal response and a greater stability of long-term results (33).

It is important to precise that in those studies, except the one of Sabouni et al., the authors were based on dental development and not the cervical maturation to estimate the age of the patients.

To conclude, half of the articles analyzed were describing the risk of incisor traumatism as a factor to choose to apply an early treatment. It seems to be an important factor to take in account to decide on the most appropriate time to start the treatment. If the risk is absent, a later, single phase treatment will be done, as it will present similar results on a skeletal level and a shorter duration.

6.1.2 Class III malocclusion

Woon et al. in 2017 (36) wrote a systematic review about early treatment for Class III malocclusion (before 12 years old). The objective of this study was to assess the effectiveness of orthopedic and orthodontic means used early in the treatment of Class III in the short and long term. The mask of Delaire was the main device that gave positive results in short term, but without proofs for the long term.

The same year, Wendl et al. (37) compared, through a retrospective study, the early and late treatments of dental and skeletal Class III. They were effective in 74% of early treatment, with less dento-alveolar compensation in group between 5 and 9 years old, and 65% of late treatments. Also, the treated groups showed more balanced skeletal relationships.

To optimize the skeletal results of class III treatment, it seems interesting to start treatment early, in temporary dentition or at the start of mixed dentition, to avoid dento-alveolar compensation of the skeletal disharmony in late treated cases and ensure a therapeutic success.

On this topic, Fleming (35) in his previously described review, described better results in early mixed dentition for the maxillary protrusion.

Finally, Staderini et al. presented a case study in 2019 (38) regarding the management of the class III by clear aligners on a 11,8 years old female patient, and so in CS4 cervical stage where she almost finished her craniofacial growth. The case showed positive overall results and stable outcome, giving to clear aligners credits in the early treatment of class III.

By the same author, last year, a case series (39) described treatment of anterior crossbite with clear aligners in two eight years old children. It was concluded that the objectives of correction were reached, making this alternative approach a good option of treatment in mixed dentition young patients.

To conclude, the majority of studies agree that their early orthopedic management (before 10 years of age), either in temporary dentition or at the start of mixed dentition, gives immediate

positive effects as well as a better skeletal response and less dento-alveolar compensation. Moreover, the absence of spontaneous positive evolution of the prevalence of Class III during growth justifies the need to treat them early. Also, it's important to remind that none of the studies cited has been able to prove that the positive effects of early orthopedic therapy are maintained over the long term.

6.2 Regarding transverse anomalies

The objective of the study of Lippold et al. in 2013 (40) was to assess the effects of early orthodontic treatment of functional unilateral posterior crossbite in children with temporary or early mixed dentition. The results showed that early treatment induced effects on maxillary growth and a better prognosis of normal craniofacial development.

Fleming (35) believes that the correction of posterior crossbites should be undertaken early, especially if it is associated with a mandibular lateral deviation to prevent it from progressing to facial asymmetry.

As for clear aligners, the case report of Dr Owen Crotty (41) for Invisalign First reports good results of early treatment in a case of posterior crossbite, especially regarding dentoalveolar expansion. It is important to precise that the patient did not have an upper arch constriction of skeletal origin. If it had been the case, as precise the author, a rapid maxillary expansion with an expander would have been necessary. In his conclusion, he even specifies that the thickness of the aligner helped to exceed the initial overbite, and no other special feature were needed to assist the correction.

To conclude, the interest of early treatment for transverse anomalies has already been demonstrated in the past, especially regarding skeletal and dentoalveolar expansion in temporary or mixed dentition. The studies exposed only confirmed its interest.

6.3 Regarding vertical anomalies

Pisani et al. (42) did a systematic review in 2016 whose objective was to evaluate the elements currently available on the treatment of anterior open bite in mixed dentition in order to prove the effectiveness of the early treatment, to evaluate the most effective treatment and the stability of the results in the long term. Each study showed a diminution in the anterior open bite, as well as a skeletal effect, hence confirmed the effectiveness of treatment in mixed dentition. However, due to the lack of controlled trials, the lack of standardization of diagnostic, inclusion or measurement criteria, no meta-analysis could be performed. It was also the case in another review wrote the same year by different authors.

Fleming (35) also wrote about the management of anterior open bite and concluded that functional openings respond well to early treatment, skeletal open bite will require correction after growth and finally the frequency, duration and intensity of digital sucking influence this anomaly.

In 2017, Al Hamadi et al. (43) wrote a review about orthodontic treatment timing and modalities. They found successful result for early treatment but no best time treatment. Like Fleming, they highlight the functional problems and the importance of treating them as soon

as possible by removing the parafunctional habits. Again, more studies are required for long term evaluation.

Regarding clear aligners, Dr Ronny Lie wrote a case report (44) for Invisalign First about a 10,5 years old patient with anterior open bite and incisors protrusion (regarding the latter, the article mentioned the importance to treat incisors protrusion early due to the risk of traumatism it presents, like exposed previously in this work). The treatment received during early mixed dentition demonstrated an excellent control of the vertical dimension and excellent result.

Finally, it seems of interest to take for support the article of Rosa et al. of 2019 (45) where the treatment of anterior open bite in mixed dentition is questioned. For them, the treatment should aim the other factors of the malocclusion and the parafunctional habits of the patient, prior to the active treatment of the anterior open bite. As well, it should be taken into account the self-amelioration that happens in puberty.

To conclude, the main problem seems to be anterior open bite. These are often due to dysfunctional habits that are of crucial importance to treat as soon as possible, ideally in temporary dentition. For most of those studies, early treatment in mixed dentition phase showed good results in the interception of anterior open bite, but each case is particular and treatment plan should be adapted to each patient.

7. Recent incorporations in Invisalign

7.1 MAF (Mandibular advancement features)

Mandibular advancement feature or MAF, is one of the latest innovation from Invisalign system and the first specialized for class II treatment in growing patients, dental and skeletal with mandibular retrognathia, before the prepuberty growth spurt (3). It consists of a pair of wings, called “precision wings” placed between second premolars and first molars, both on the upper and lower aligners (figure 5). Those wings, by interlocking, push the mandible forward in a more protrusive position than the occlusion in maximum intercuspation of the patient. Meanwhile, levelling and alignment are done thanks to the aligners, and a mesio-vestibular rotation of the molars is realized to correct the class II. This simultaneous double action allows to have a shorter treatment time and by doing so, increase the satisfaction of the patient and his parents that can observe improvements rapidly. For MAF, aligners are changed every week.

MAF is a new alternative to functional appliances and elastics that are routinely used to treat class II growing patients. It has the advantage to be much easier to wear but, however, the patient should not have short clinical crowns to allow the required retention. Also, the second temporary molar should be in place or, if not, the second premolar, otherwise Invisalign can refuse the placement of MAF.

In the article of Sabouni et al. of 2019 (REF) entitled “Class II treatment for patients during growth using thermoformed splints: which protocol?”, the authors evoked the MAF in one of their clinical case. They proposed three different approaches depending on the malocclusion

in the sagittal dimension, in a 11 years old patient between CS3 and CS4 in cervical stage of maturation which corresponds to puberty growth spurt:

- If it is inferior to 2mm, they recommend the use of class II elastics with heavy forces to stimulate the mandibular growth.
- If it is between 2 and 5mm, they recommend the use of MAF with a progressive advancement of 2mm every 8 aligners.
- If it is superior to 5mm, they recommend the use of MAF followed, in a second time, by a sequential distalization with aligners.

Treatment outcome showed satisfactory results, both the bite and chin appearance have improved.



Figure 5: Mandibular advancement Feature (9)

7.2 Invisalign Stickables

Last year, in September 2020, Align technology (3) announced the launch of “Invisalign Stickables” (figure 6). They claim that those stickers allow the kids to be unique and “express their smile”, basing this idea on the fact that kids appreciate to show and stand out from others, to look cool and different when they smile.

Those stickers, design to customize clear aligners made of Smart Track material exclusively, are made of several layers of water-resistant and biocompatible plastic. They are declined in ten different themes, counting food or gaming themes for example, multiplying the choices for the kids and making their treatment “more fun”.

It would be interesting to encounter, in the near future no doubt, new research describing the impact on young patients of these new stickables.

For now, stickers are only available in US and Canada, their launch in other countries is planned to be during this year and purchase will be accessible through the webstore in Invisalign Doctor Site.

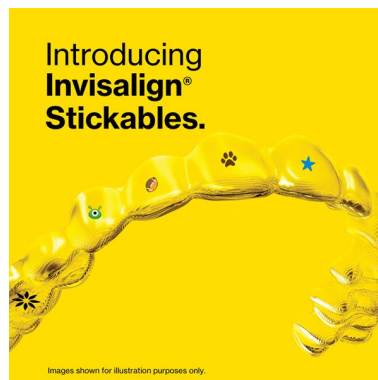


Figure 6: Invisalign Stickables (3)

CONCLUSIONS

- 1) Invisalign First and Invisalign Teen are two systems of a great interest. Both present features that ease the work of the professional and the life of patients and their parents. In a generation where esthetics has its importance, Invisalign finds its place for growing patients, with a bright future ahead.
- 2) Regarding the factors analyzed, Invisalign system presents more advantages than FOA system that, however, keeps an important place in orthodontic treatments with a better predictability.
- 3) The interest of early treatment has been already demonstrated in the past. In terms of cervical stage maturation, the ideal moment seems to be between C3 and C4. Nevertheless, each case is particular and treatment plan should be adapted to each patient.
- 4) MAF is of great interest in the treatment of Class II with its simultaneous double action: dental alignment and mandibular advancement. A more harmonious profile can now be obtained while having the aesthetics and discretion of Invisalign clear aligners. Finally, Invisalign Stickables could lead to success with the targeted population.

RESPONSIBILITY

In the last 2 years, Align technology has highlighted its eco-responsible aspect by explaining on their website their commitments to the environment, such as the recycling of aligners made of plastic or the reduction of packaging production. As well, the use of iTero scanners has an impact by reducing the consumption of impression material.

But even if recyclable, our society gradually tends to eliminate plastic from our environment: will Invisalign have to find another type of material? If we compare with FOA, the recyclable side of plastic becomes more interesting compared to certain metals used in the composition of brackets, whose elimination can be problematic. Another aspect is the factory where aligners are manufactured, located in Mexico: the transport of these aligners to Europe represents a significant carbon footprint. However, Invisalign is reportedly considering opening factories in Europe. Finally, on a much smaller scale, in terms of the carbon footprint, Invisalign treatments require fewer appointments and therefore less trips to the dental office. From a social point of view, clear aligners are esthetically the best on the market and therefore improve the well-being of all users. In a society where esthetic takes an important place, for adults and increasingly for young generations, Invisalign has a promising future ahead.

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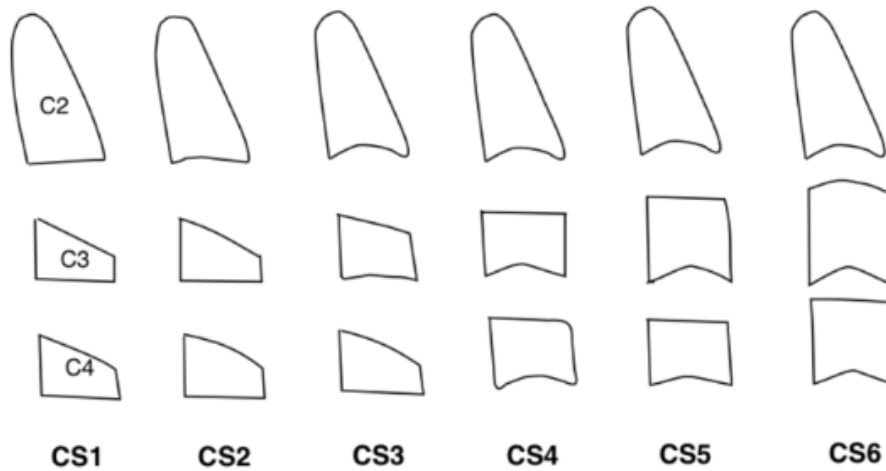
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ANNEXES

Table 1 The 6 cervical stages of maturation and their relation to the mandibular growth peak



| Cervical Stage | C2 – Lower Border | C3 – Lower border C3 – Body | C4 – Lower border C4 – Body | Peak Mandibular Growth |
|----------------|-------------------|---|--|---|
| 1 | Flat | Flat Trapezoid | Flat Trapezoid | On average 2 years after this stage |
| 2 | Concave | Flat Trapezoid | Flat Trapezoid | On average 1 year after this stage |
| 3 | Concave | Concave trapezoid or rectangular horizontal | Flat trapezoid or rectangular horizontal | During the year after this stage |
| 4 | Concave | Concave rectangular horizontal | Concave rectangular horizontal | Within 1–2 years before this stage |
| 5 | Concave | Concave rectangular horizontal or square | Concave rectangular horizontal or square | Finished at least 1 year before this stage |
| 6 | Concave | Concave square or rectangular vertical | Concave square or rectangular vertical | Finished at least 2 years before this stage |

Extracted from article 10

Table 2 Overview of the studies about periodontal health, salivary level of bacteria and speech articulation

| Authors | Type of study | Sample & age | Parameter analyzed | Results |
|-----------------------------|--------------------|---------------------------|--|---|
| <i>Abbate et al. (2015)</i> | Experimental study | n = 50 10-18 years old | Periodontal health in Invisalign vs. FOA | In Invisalign group: - Higher compliance with OH - Less plaque - Fewer gingival inflammatory reactions |

| | | | | |
|---|--------------------------|----------------------------|---|--|
| <i>Azaripour et al. (2015)</i> | Cross-sectional study | n = 100 11-62 years old | Gingival parameters and patient's satisfaction in Invisalign vs. FOA | In Invisalign group: - Better gingival health - Less plaque - Greater patient's satisfaction |
| <i>Sifakakis et al. (2018)</i> | Prospective cohort study | n = 30 12-18 years old | Salivary levels of cariogenic bacteria during FOA vs. Invisalign treatments | - No significant difference of <i>S.mutans</i> counts between the 2 groups - Lower <i>S.sanguinis</i> count in Invisalign |
| <i>Pogal-Sussman-Gandia et al. (2019)</i> | n/a | n = 30 14-62 years | Effect of Invisalign on speech articulation | - Misarticulation of consonants, being in order /z/and /s/ the most impacted - The consonant /sh/ was not affected |

Table 3 Overview of the studies about outcome, accuracy and effectiveness

| Authors | Type of study | Sample & age | Parameter analyzed | Results |
|-------------------------------|------------------------------|---|---|--|
| <i>Pavoni et al. (2011)</i> | Prospective study | n = 40 Mean age of patients - FOA: 15,6 years - Invisalign: 18,4 years | Dento-alveolar effects during FOA vs. Invisalign treatments | - No significant differences in treatment duration - Invisalign can easily tip crown but not roots |
| <i>Buschang et al. (2014)</i> | Prospective study | n = 300 16-29 years old | Treatment duration and chair time FOA vs. Invisalign | - FOA required more routine and emergency visits, and so chair time compared to Invisalign |
| <i>Zheng et al. (2017)</i> | 4 Controlled clinical trials | n = 252 | Treatment duration, chair time and effectiveness FOA vs. Invisalign | - Shorter treatment duration and chair time in Invisalign - Evidences about its effectiveness are lacking |
| <i>Haouili et al. (2020)</i> | Prospective follow up study | n = 38 with Invisalign Full | Accuracy of tooth movements | - Overall mean accuracy of 50% |

| | | | | |
|--|--|--------------------|-----------------|--|
| | | or Invisalign Teen | with Invisalign | <ul style="list-style-type: none"> - Highest accuracy was achieved with buccal lingual crown tip (56%) - Lowest accuracy occurred with rotation (46%), movements difficulties with canines, premolars and molars |
|--|--|--------------------|-----------------|--|

Table 4 Overview of the articles relating timing of treatment

| Authors | Type of study | Sample & age | Parameter analyzed | Results |
|------------------------------|--|--|--|--|
| <i>Suresh et al. (2015)</i> | Critical review | Patients in mixed dentition | 1 phase vs. 2 phases treatments | <ul style="list-style-type: none"> - Importance of treatment planning - Growth helps and enhance the stability of the results |
| <i>Oh et al. (2017)</i> | Retrospective study | 3 groups of class II subjects <ul style="list-style-type: none"> - Early treatment (7-9,5 years) - Late treatment (12-15 years) - Control group | To evaluate the effectiveness of an early treatment in class II mixed dentition patients | <ul style="list-style-type: none"> - Effective in mixed dentition to reduce the permanent tooth extractions - More extractions in the late treatment group - Reduce treatment time in permanent dentition |
| <i>Sabouni et al. (2019)</i> | Clinical cases | 1) Before CS3 (patient is 8 yo) 2) CS3-CS4 (patient is 11 yo) 3) After CS4 (patient is 16 yo) | Treatment of Class II with clear aligners | 1) Correction of transverse anomalies and mandibular unlocking 2) Mandibular growth stimulation with elastics or wings 3) Compensation treatment by distalization, extractions or surgery in more complex cases |
| <i>Woon et al. (2017)</i> | Systematic review and meta-analysis of 9 RCT and 6 CCT | 7-12 years | Effectiveness of orthodontics in early | <ul style="list-style-type: none"> - Early treatment with facemask has good skeletal and dental results in short term |

| | | | | |
|--------------------------------|---------------------------|--|--|--|
| | | | treatment of Class III | - Lack of evidence in long term |
| <i>Wendl et al. (2017)</i> | Retrospective study | n = 38 | Success and failure of Class III treatments | - Effective in 74% of early and 65% of late treatments - Early treated groups show more balanced skeletal relationships - Late treated showed more dento-alveolar compensation |
| <i>Staderini et al. (2019)</i> | Case study | 11,8 years old female patient | Treatment of Class III with clear aligners | - At 1 year follow up, clear aligners therapy resulted in skeletal and dental improvement |
| <i>Lippold et al. (2013)</i> | Randomized Clinical Trial | n treatment group = 31 (control group n=35) 7,3 years | Effect of early treatment in posterior crossbite | - Significant differences between treatment and control groups - Induce maxillary growth effect - Better craniofacial growth prognosis, dental occlusion improved |
| <i>Pisani et al. (2016)</i> | Systematic review | n = 240 studies selected | Effectiveness in early treatment to treat anterior open bite | - Confirms the effectiveness of early treatment of open bite: at dental and skeletal levels - Better trial designs and more studies should be made |
| <i>Al Hamadi et al. (2017)</i> | Case series study | n = 5 7-27 years | Evaluate the best time of treatment and its modalities | - Successful results for early treatment but no best time of treatment - Important to treat functional problems - More studies are required for long term evaluation |

CLEAR ALIGNER TECHNIQUE

Sandra Tai, BDS, MS



Influence of thermoplastic appliance thickness on the magnitude of force delivered to a maxillary central incisor during tipping

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Introduction: The aim of the study was to quantify the forces delivered by thermoplastic appliances made of 2 materials with 2 thicknesses to a maxillary central incisor during tipping. **Methods:** Two materials were tested, each in 2 thicknesses: Erkodur (Erkodent Erich Kopp GmbH, Pfalzgrafenweiler, Germany) 1.0 and 0.8 mm, and Biolon (Dreve Dentamid GmbH, Unna, Germany), 1.0 and 0.75 mm. For each material, 5 appliances were produced. To measure the forces applied, an isolated measuring tooth, part of a standardized resin model, was deflected in 0.05° steps from 0° to 0.42° in the vestibular and palatine directions, after placing the respective appliance on the model. For statistical analysis, the force components Fx/tipping and Fz/intrusion at a displacement of ± 0.151 mm from the incisor edge were selected. Means and standard deviations were calculated. The Wilcoxon 2-sample test for group pairings was used. **Results:** The norms for the mean Fx forces ranged from 1.62 (SD, 0.41) to 5.35 N (SD, 0.63). The mean Fz forces were between 0.07 (SD, 0.13) and -2.47 N (SD, 0.34). The highest intrusive forces were measured during vestibular displacement of the measuring tooth. The forces delivered by the thick appliances were overall significantly higher ($P < 0.0001$) than those of the thin materials. The forces delivered by the Biolon appliances were generally significantly higher ($P < 0.0001$) than those for the Erkodur materials. **Conclusions:** The forces applied were mostly too high when compared with those stated in the literature as ideal. In addition to thickness, the thermoforming process influences the magnitude of the force delivered by a thermoformed appliance. (Am J Orthod Dentofacial Orthop 2009;136:12.e1-12.e7)

As a result of increased interest in adult orthodontic treatment, esthetic alternatives to conventional fixed appliances are often requested. Therefore, various types of thermoplastic appliances have been introduced in orthodontics.

The technique was originally introduced by Kesling¹ and subsequently improved as an alternative or a supplement to fixed appliances.^{2,3}

For the commercial ClearSmile system (ClearSmile Pty Ltd, Keiraville, Australia), a dental technician resets the teeth on a plaster model by hand and forms an overlay appliance for every desired step of tooth movement.⁴

Align Technology (Santa Clara, Calif) uses a series of computer-generated thermoplastic appliances constructed on stereolithographic models.^{5,6} Despite documentation of successful treatments, the force delivery properties of various appliances have still not been systematically investigated, and only a few studies have been published on this topic.⁷⁻⁹

The forces imparted by a thermoplastic appliance to a maxillary first premolar in vivo were measured by Barbagallo et al⁴ using a pressure-film approach.

One study was published recently concerning the influence of thickness of the appliances on force delivery.¹⁰ In this study, 3-point bending and recovery tests were performed on standardized, flat specimens.

The aim of our study was to quantify the force components with focus on the tipping and intrusive forces generated by removable thermoplastic appliances made of 2 hard thermoplastic materials with 2 thicknesses on a maxillary central incisor during tipping.

MATERIAL AND METHODS

We recently developed a modular force-torque device for measuring forces in orthodontic research. It

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The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.

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Submitted, October 2008; revised and accepted, December 2008.

0889-5406/\$36.00

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doi:10.1016/j.ajodo.2008.12.015



Force delivery properties of thermoplastic orthodontic materials

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Introduction: Our objectives were to evaluate the force and energy (resilience) delivery properties of thermoplastic overlay orthodontic materials and to determine the changes in force delivery properties after thermocycling or repeated load cycling. **Methods:** Three types and 3 thicknesses of materials were investigated. Three-point bending-recovery tests were performed at baseline and after cycling procedures. For cycling, the specimens were thermocycled for 1000 cycles or repeatedly deflected by 1 mm for 100 cycles. Vickers hardness was measured to determine the changes after thermocycling or repeated load cycling. **Results:** The amount of deflection for optimal force delivery was 0.2 to 0.5 mm. Thin material exerted high energy in the deflection range of optimal force delivery. In the deflection ranges of optimal force delivery (0.2-0.5 mm), the force delivery properties after thermocycling were not different from those at the baseline ($P > .01$) but were different after repeated load cycling ($P < .01$). Thermocycling and repeated load cycling influenced Vickers hardness significantly. **Conclusions:** Thin material (0.508 mm) can deliver higher energy than thick materials (0.762 or 1.016 mm, $P < .01$) of the same brand. Therefore, thin material should be selected in the same brand of material. The effect of repeated deflection during service should be considered. (Am J Orthod Dentofacial Orthop 2008;133:228-34)

Clear thermoplastic overlay appliances take various forms, including retainers,¹⁻³ night guards, temporomandibular joint splints, and bleaching trays.⁴ These appliances have been used for minor tooth movements.^{1-3,5} Recently, thermoformed orthodontic thin overlay appliances have been introduced as alternatives to conventional brackets and archwires. Tooth movement without bands, brackets, or wires was described as early as 1945 by Kesling,⁶ who reported a flexible tooth-positioning appliance. Later, various types of overlay appliances such as invisible retainers were introduced.¹⁻³ The superior shape-memory properties of these materials make minor tooth movements possible with tooth positioners.^{1-3,5}

Minor tooth movements with overlay appliances have been achieved with a technique developed by

Raintree Essix (New Orleans, La).³ The clear aligner was modified with a divot or a window. This type of appliance is claimed to be effective in correcting mild discrepancies in the alignment of teeth. In this system, tooth movement is limited to 2 to 3 mm; beyond this range, a new appliance based on the corrected position of the teeth is recommended.³

The Invisalign system was introduced by Align Technology (Santa Clara, Calif).⁷ This esthetic and removable system can move tooth from the beginning to the end of treatment. The number of necessary stages depends on the amount and complexity of tooth movement.

Both systems deliver force to a target tooth as the resilient plastic returns to its resting state. The ideal amounts of tooth resetting at each stage, claimed by the manufacturers, are 0.25 to 0.33 mm by Align Technology⁷ and 0.5 to 1.00 mm by Raintree Essix.⁸ If the amount of tooth resetting is not adequate, the tooth movement that the operator intended is not obtained. Ideal orthodontic treatment requires optimal force delivery that leads to a maximum rate of tooth movement with minimal irreversible damage to the tissues.⁹ It was reported that the optimal force for the tipping movement of 1 tooth is 50 to 75 g.¹⁰

Thermoplastic overlay orthodontic appliances are generally recommended to be used for 2 weeks in each stage. During this period, temperature fluctuations in the oral cavity can change the properties of these materials. These appliances are also subject to deflection changes during placement in or removal from the

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Supported by a grant of the Korea Health 21 R&D Project, Ministry of Health and Welfare, Republic of Korea (03-PJ1-PG1-CH09-0001).

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Submitted, January 2006; revised and accepted, March 2006.

0889-5406/\$34.00

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doi:10.1016/j.ajodo.2006.03.034

RESEARCH

Open Access



Clear aligner treatment: different perspectives between orthodontists and general dentists

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Abstract

Purpose: To evaluate differences between orthodontists and general dentists in experience with clear aligners (CA), patients' demand and perception, types of patients, and malocclusion treated with CA and to compare the two groups of clinicians not using CA in their practice.

Methods: A Web-based survey was developed and sent to the 129 members of the European Aligner Society and randomly to 200 doctors of dental surgery by e-mail. They responded on demographics and to one of two different parts for clinicians using CA or not using CA. Statistical analysis was performed with SAS EGv.6.1.

Results: The response rate was 74%. Among the total of respondents, the majority reported utilizing CA in their practice with a greater percentage of orthodontists ($P = 0.0040$). Overall, orthodontists learned more about CA during academic seminars comparing to general dentists, and they treated more class I with crowding ($P = 0.0002$) and with open bite ($P = 0.0462$). The majority of patients treated with CA were female and adults with a full-time employment, and the patients' knowledge about CA treatment was mainly provided by information from external media advertising. For respondents not using CA, orthodontists were more likely to report that CA limit treatment outcomes, whereas general practitioners were reported not having enough experience to use them.

Conclusions: There were some significant differences between orthodontists and general dentists mainly in experience and case selection for clinicians using CA as well as in the reasons provided for not using CA in their practice.

Keywords: Aligners, Orthodontists, General dentists, Malocclusion, Patients' perception

Background

Clear aligners (CA) have been used in orthodontics since 1946 when Dr. Harold Kesling introduced the use of a series of thermoplastic tooth positioners to obtain tooth alignment [1]. CA treatment has evolved mainly over the last 15 years through new technologies and materials to widen the range of tooth movements [2]. The main advantages of CA treatment are better esthetics with higher patient acceptance and a general better quality of life [3]. CA treatment causes less pain compared to a traditional fixed treatment [4] and also an improvement of the gingival and

periodontal health indexes. The treatment with CA is usually performed in combination with other orthodontic auxiliaries and procedures such as attachments, interarch elastics, and interproximal reduction [5]. However, there are some significant limitations in treating complex malocclusions, i.e., the limited root-movement control, the intermaxillary discrepancy correction, the anterior extrusion, and rotation movement [6–8]. Moreover, the reliance on patient compliance has been also reported as an important variable for the CA treatment outcome [9, 10]. The clinicians who want to use CA to treat their patients have to rely on their own clinical experience, expert opinions, and limited published evidence-based results [11–14]. CA can be provided by both orthodontists and general dentists; however, some significant differences were evinced between the two groups in the use of a CA treatment in their clinical

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**Orthodontic marketing through social media networks:
*The patient and practitioner's perspective***

Kristin L. Nelson^a; Bhavna Shroff^b; Al M. Best^c; Steven J. Lindauer^d

ABSTRACT

Objective: To (1) assess orthodontic patient and practitioner use of and preferences for social media and (2) investigate the potential benefit of social media in marketing and communication strategies in orthodontic practices.

Materials and Methods: A survey was developed and randomly distributed to orthodontists via the American Association of Orthodontists and to patients/parents via private practices throughout the United States. Participants were asked to answer questions related to their use of social media and their perceptions of the use of social media in the orthodontic practice.

Results: Of the participants, 76% of orthodontists and 89% of patients/parents use social media. Furthermore, Facebook was the social media platform that was most preferred. Social media use was more common in female and younger adult participants. Orthodontists posted information more often in the morning (40%) and afternoon (56%), and patients/parents used social media mainly in the evening (76%). The most commonly used marketing strategies in the orthodontic practices were social media (76%) and a practice website (59%). Social media and practice websites were positively related with new patient starts ($P = .0376$, $P = .0035$, respectively).

Conclusions: Most orthodontists and patients/parents used social media. Social media may be an effective marketing and communication tool in an orthodontic practice. (*Angle Orthod.* 0000;00:000–000.)

KEY WORDS: Orthodontics; Social media; Marketing

INTRODUCTION

The introduction of social media has revolutionized the way people interact through the social Web.¹ Social media is defined as online technologies and practices that people use to share opinions, experiences, and perspectives with each other.² These websites allow people to have a dialogue with their friends, family, and other people in a global environment. As a result,

millions of people have started communicating through social media websites. One of the most popular social media websites, Facebook, has grown into a worldwide network of more than 1 billion subscribers since its creation in 2004.¹

Although social media networks were originally created for personal use, they are now effectively used by businesses of all sizes to advertise their products or services and to communicate with current and prospective consumers.³ Compared with traditional advertising, social media marketing is an interactive, cost-effective, and more efficient solution for promoting services and products, especially because more customers are spending time online.³ According to a recent report, Facebook was the number one social marketing tool used by companies with 100+ employees, followed by Twitter.⁴ In a study on consumer behavior, 51% of the consumers recognized that they were more likely to buy a product after becoming a fan on Facebook.⁵

The benefits of social media marketing are currently seen in the field of health care, and social media a major tactic in dental marketing. Social media marketing is a

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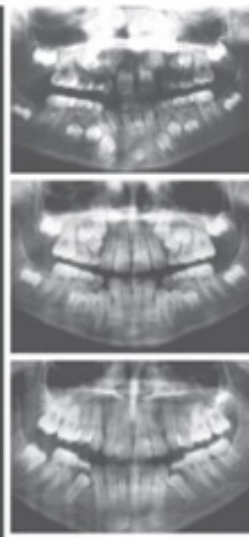
Accepted: January 2015. Submitted: November 2014.

Published Online: March 4, 2015

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INTERCEPTIVE ORTHODONTICS

A Practical Guide to
Occlusal Management



Joseph Noar

WILEY Blackwell

C L I N I C A L C A S E

INVISALIGN for adolescents: an alternative to multibracket attachments? Illustrated treatment of a clinical case

Jean-François CHAZALON

INTRODUCTION

Even if multibracket orthodontic appliances have long been the treatment of choice for adolescents, one of the more recent innovations is the possibility of treating them by using a system of transparent trays custom-made for the individual: INVISALIGN TEEN (2009).

Though similar to INVISALIGN, it features different functionalities required to respond to the specific needs of our young patients.

The compliance indicators make it possible to monitor the good cooperation of our

patients regarding the number of hours they wear the aligners (20 to 22 hours a day).

The presence of eruption guidance pontics and eruption tabs take into account the future eruption of the last permanent teeth and make it possible to begin our treatment in the mixed dentition.

The case shown here presents the management of a patient using this technique.

1 – PRESENTATION OF THE CASE (05.2010)

Pauline O., a young patient 12 years old, comes in for a consultation because she “doesn’t like her teeth and thinks they jut out”.

The extraoral examination shows a recessed profile with a slightly retruded mandible and a pronounced labiomental fold. The smile shows protruded upper teeth.

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Article available at <http://www.jdao-journal.org> or <http://dx.doi.org/10.1051/odfen/2013308>

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CONTEMPORARY ORTHODONTICS

Sixth Edition

ELSEVIER



Forecasting the timing of peak mandibular growth in males by using skeletal age

W. Stuart Hunter,^a Sheldon Baumrind,^b Frank Popovich,[†] and Gertrud Jorgensen^c

London and Toronto, Ontario, Canada, and San Francisco, Calif

Introduction: It is generally believed that the orthodontic treatment of a patient with a Class II malocclusion and a small mandible is enhanced by good growth at puberty, so that the timing of peak mandibular growth at puberty becomes of interest. **Methods:** To test the belief that skeletal age, whether early, average, or late, can be used to predict the timing of maximum growth of the mandible, whether early, average, or late, the predictive relationship between skeletal age and peak mandibular growth velocity (PMdV) at puberty was evaluated in 94 boys by using their longitudinal records from 4 to 18 years of age. Skeletal age was determined for each subject at ages 9 through 14 by using the method of Greulich and Pyle. **Results:** At age 9, the Greulich and Pyle measurements predicted that 30 of the 94 subjects would have delayed PMdV equal to or exceeding 1 SD (of the mean age for PMdV), and 10 would have advanced PMdV equal to or exceeding 1 SD. When the actual age of PMdV was determined retrospectively from plots of annual mandibular growth increments, it was found that only 4 of the 30 in the delayed group had actually experienced delays in PMdV, and only 2 of the 10 in the advanced group had experienced accelerated PMdV. **Conclusions:** Skeletal age is not a reliable predictor of the timing of PMdV. (*Am J Orthod Dentofacial Orthop* 2007;131:327-33)

Many orthodontists believe that the treatment of Class II malocclusion is optimized when it can be timed to take place during the period of greatest mandibular growth. Identifying that period in each patient is complicated because the pubertal growth spurt occurs at various chronological ages. Hence, it would be desirable to have a reliable way of forecasting when the maximum growth of the mandible at puberty will occur in a patient. Skeletal age derived from the maturation stages of the carpals and metacarpals has been used for that purpose for over half a century.

Houston et al¹ observed that "If advantage is to be taken of the growth spurt, it is necessary to predict its timing at least 1 or 2 years in advance of peak height velocity (PHtV)." Otherwise, the advanced patients will already be into their pubertal spurt. In the sample of boys in this study, the average ages were 13.2 ± 0.9 years for PHtV and 13.9 ± 1.2 years for peak mandibular velocity (PMdV).

Reports that support the use of skeletal age to forecast

whether PMdV will be delayed or advanced include those by Hunter,² Bjork and Helm,³ Helm et al,⁴ Bjork,⁵ Bowden,⁶ Hagg and Taranger,^{7,8} and Demirjian et al.⁹ All used skeletal age to forecast the timing of PHtV at puberty, assuming that the relationship of PHtV and PMdV is very close. None explained how the use of skeletal age improves treatment or treatment planning.

To examine the relationship between skeletal age and PMdV, we tested the hypothesis that, when skeletal age at 9 years is delayed (or advanced) by 1 year or more, the succeeding PMdV will be similarly delayed (or advanced). We report the results of tests of this hypothesis for a sample of 94 growing boys enrolled in the Burlington Orthodontic Research Centre (BORC).¹⁰ The relationship between skeletal age at 9 and PHtV was also examined.

MATERIAL AND METHODS

The longitudinal records on which this study is based were drawn from the records of the BORC, housed in the Department of Orthodontics, Faculty of Dentistry, University of Toronto. See Popovich and Thompson¹⁰ and Hunter et al¹¹ for a description of the annual serial sample characteristics. The sample included 85% to 90% of all 3-year-old boys in Burlington when the study began in 1952 and Burlington's population was 9000. Although there were 172 boys at the beginning, that number had decreased significantly by the time they were 18 years of age.

The portion of the available materials relevant to our project included x-ray images and data for 122 boys

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Submitted, June 2006; revised and accepted, September 2006.

0889-5406/08/32.00

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doi:10.1016/j.ajodo.2006.09.036

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Assessment of Growth in Orthodontics

Abstract: Being able to predict the likely timing and duration of growth accurately, in particular the pubertal growth spurt, is important in orthodontic treatment planning. The different assessments of growth, their advantages and disadvantages will be described.

CPD/Clinical Relevance: A knowledge of the typical assessments of skeletal growth is important in the planning and execution of orthodontic treatment.

Ortho Update 2017; 10: 16–23

Growth can be defined as an increase in cellular size and number and can be linked with development, including an increase in specialization or function.¹ It is certainly an important factor in orthodontics as it can both directly and indirectly influence treatment. The obvious direct effect is potential growth modification in both Class 2^{2,3,4} and Class 3 skeletal cases.^{5,6} Similarly, growth can have a direct and sometimes adverse effect on the occlusion and therefore delay treatment. For example, a Class III skeletal pattern may become more severe, as might an anterior open bite. In such cases, treatment may have to be put on hold until growth has essentially ceased. The presence or absence of growth may also have a less obvious and more indirect effect on orthodontic treatment. For example, overbite reduction is often easier in the growing child and, more recently, it has been reported that the rate of active tooth movement is likely to be greater at times of rapid growth, particularly around the time of the pubertal growth spurt.⁷

As part of an orthodontic assessment therefore, it is essential to

consider the likely direction, magnitude and perhaps, most importantly, the timing of growth in our patients. All children with a normal pattern of growth will undergo a pubertal growth spurt. For each individual, however, there are differences in the onset, duration, velocity and amount of growth over this period.^{8,9,10} In an attempt to predict growth, in particular the timing of the pubertal growth spurt, a number of assessment methods have been described. These include chronological age, stage of dental development, the plotting of standing height measurement on growth charts, the stage of development of secondary sexual characteristics and radiographic measures of skeletal maturation.

At this point it is perhaps worth considering the properties of an ideal clinical growth assessment tool. These include:

- Easy to use;
- Safe;
- Accurate;
- Reliable;
- Valid;
- Non invasive;
- Cost-effective.

Successful treatment in the growing patient is often dependent on knowing the growth status of the particular individual. Therefore, an understanding of growth predictors and maturity indicators is paramount for the clinician. These will be discussed in turn.

Chronological age

A number of variables including mental maturity, physical capacity, height and weight are sometimes estimated according to chronological age.¹¹ However, there can be wide differences between individuals of the same age, as a number of genetic and environmental factors, including nutrition, endocrine status, metabolic status and other medical conditions, can affect development.¹² Therefore, chronological age on its own cannot be used as a valid parameter to estimate facial growth or skeletal maturity.¹¹

Dental development

Similarly, it has been proposed that a link exists between dental development, skeletal age and chronological age.¹³ A technique has been described

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Orthodontic Management of the Developing Dentition

An Evidence-Based Guide

Martyn T. Cobourne
Editor

 Springer

ORIGINAL ARTICLE

Colour stabilities of three types of orthodontic clear aligners exposed to staining agents

Chen-Lu Liu, Wen-Tian Sun, Wen Liao, Wen-Xin Lu, Qi-Wen Li, Yunho Jeong, Jun Liu and Zhi-He Zhao

The aim of this study was to evaluate and compare the colour stabilities of three types of orthodontic clear aligners exposed to staining agents *in vitro*. Sixty clear orthodontic aligners produced by three manufacturers (Invisalign, Angelalign, and Smartee) were immersed in three staining solutions (coffee, black tea, and red wine) and one control solution (distilled water). After 12-h and 7-day immersions, the aligners were washed in an ultrasonic cleaner and measured with a colourimeter. The colour changes (ΔE^*) were calculated on the basis of the Commission Internationale de l'Éclairage $L^*a^*b^*$ colour system (CIE $L^*a^*b^*$), and the results were then converted into National Bureau of Standards (NBS) units. Fourier transformation infrared (FT-IR) spectroscopy and scanning electron microscopy (SEM) were conducted to observe the molecular and morphologic alterations to the aligner surfaces, respectively. The three types of aligners exhibited slight colour changes after 12 h of staining, with the exception of the Invisalign aligners stained with coffee. The Invisalign aligners exhibited significantly higher ΔE^* values (ranging from 0.30 to 27.81) than those of the Angelalign and Smartee aligners (ΔE^* values ranging from 0.33 to 1.89 and 0.32 to 1.61, respectively, $P < 0.05$). FT-IR analysis confirmed that the polymer-based structure of aligners did not exhibit significant chemical differences before and after the immersions. The SEM results revealed different surface alterations to the three types of aligner materials after the 7-day staining. The three types of aesthetic orthodontic appliances exhibited colour stability after the 12-h immersion, with the exception of the Invisalign aligners stained by coffee. The Invisalign aligners were more prone than the Angelalign and Smartee aligners to pigmentation. Aligner materials may be improved by considering aesthetic colour stability properties.

International Journal of Oral Science advance online publication, 23 September 2016; doi:10.1038/ijos.2016.25

Keywords: aesthetics; clear aligner; clear aligner material; colour stability; orthodontic appliance

INTRODUCTION

The aesthetic considerations associated with social perceptions influence orthodontic treatment.^{1–2} The increasing demand for more aesthetic orthodontic appliances has elicited an aesthetic revolution marked by the emergence of invisible appliances, such as aesthetic brackets, lingual appliances, and clear aligners.^{3–5} Among these appliances, clear aligners are often preferred over brackets by adults, owing to aesthetic and comfort considerations.^{6–7}

The clear aligner treatment process is based on the sequential use of aligners made of transparent thermoplastic materials.⁸ Various thermoplastic materials are currently used for fabrication,⁹ including polyvinyl chloride,¹⁰ polyurethane (PU),¹¹ polyethylene terephthalate (PET),¹² and polyethylene terephthalate glycol (PETG).^{10,12} Many studies have been conducted on clear aligners, particularly focusing on the mechanical properties of the aligners^{13–15} or the biomechanics of tooth movement during orthodontic treatment.^{12,16} Researchers have also investigated new clear aligner materials to obtain desirable

mechanical properties for orthodontic treatment.¹⁷ However, although clear aligners are promising aesthetic orthodontic appliances, the aesthetic stability of clear aligner materials has scarcely been reported.

From an aesthetic perspective, the colour stability and transparency of orthodontic clear aligners should be stable during the 2-week orthodontic treatment periods.^{18–19} However, the colour stability of dental materials is often influenced by various factors, such as ultraviolet irradiation, staining beverages, and mouthwashes.²⁰ Studies have reported that PU-based elastomeric ligatures are vulnerable to pigment adsorption from food and drink in the oral cavity.^{21–23} During usage, it is recommended that aligners be removed before eating and drinking. However, studies have reported that patient compliance regarding removable orthodontic appliances is insufficient,²⁴ and this often is a matter of concern for orthodontists. The exposure of the aligner to staining agents in the oral cavity is inevitable, especially when users drink without taking the aligners out of their mouths because of time constraints during work. Statistics

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Accepted 3 May 2016

RESEARCH ARTICLE

Open Access



Braces versus Invisalign®: gingival parameters and patients' satisfaction during treatment: a cross-sectional study

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Abstract

Background: Fixed orthodontic appliances (FOA) temporarily interfere with periodontal health of patients, as the appliance complicates oral hygiene. The use of aligners in orthodontic therapy increased strongly during the last decade. In the literature, the reports about effects of aligner treatment on oral hygiene and gingival conditions are scarce. This cross-sectional study evaluated oral hygiene and patient's satisfaction during orthodontic treatment of patients with FOA or Invisalign®.

Methods: 100 patients (FOA = 50, Invisalign® = 50) were included who underwent orthodontic treatment for more than 6 months. Clinical examinations were performed to evaluate patients' periodontal condition and were compared with clinical data at the beginning of the orthodontic treatment. Oral hygiene, patients' satisfaction and dietary habits were documented by a detailed questionnaire. For statistical analysis, the Mann-Whitney U-Test and Fisher's Exact Test were used; as multiple testing was applied, a Bonferroni correction was performed.

Results: At the time of clinical examinations, patients with FOA were in orthodontic therapy for 12.9 ± 7.2 months, whereas patients with Invisalign® were in orthodontic therapy for 12.6 ± 7.4 months. Significantly better gingival health conditions were recorded in Invisalign® patients (GI: 0.54 ± 0.50 for FOA versus 0.35 ± 0.34 for Invisalign®; SBI: 15.2 ± 7.6 for FOA versus 7.6 ± 4.1 for Invisalign®), whereas the amount of dental plaque was also less but not significantly different (API: $37.7 \% \pm 21.9$ for FOA versus $27.8 \% \pm 24.6$ for Invisalign®). The evaluation of the questionnaire showed greater patients' satisfaction in patients treated with Invisalign® than with FOA.

Conclusion: Patients treated with Invisalign® have a better periodontal health and greater satisfaction during orthodontic treatment than patients treated with FOA.

Keywords: Aligner, FOA, Braces, Dental hygiene, Periodontal health

Background

Fixed orthodontic appliances (FOA) promote the accumulation of bacterial plaque because FOA limit the ability of patients to perform good oral hygiene, which can lead to temporary destructive periodontal processes [1–4]. Deterioration of the periodontal status and dental decalcification during orthodontic treatment can be avoided only

when the patient is incorporated in a stringent recall system [5, 6].

In the majority of patients, particularly during childhood and adolescence, FOA are the treatment of choice. Because of esthetics reasons, this treatment is not very popular for adult orthodontics. Therefore, other orthodontic techniques have been developed to increase esthetics and simplify oral hygiene procedures.

An alternative for FOA is Invisalign® which has been available since 1999 and offers not only the advantage of better esthetics but also the convenience of removal during food and beverage consumption, as well as oral care.

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Caries Prevalence Measured with QLF after Treatment with Fixed Orthodontic Appliances: Influencing Factors

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Key Words

Caries prevalence · Caries risk factors · Orthodontics · Quantitative light-induced fluorescence

Abstract

Caries prevalence on the buccal surfaces of teeth in orthodontic patients was determined with QLF and visual examination immediately after removal of fixed appliances. The number of lesions found by QLF far outnumbered that found by visual examination, but the distribution pattern was similar. 97% of all subjects and on average 30% of the buccal surfaces in a person were affected. On average, in males 40% of surfaces and in females 22% showed white spots ($p < 0.01$). Caries prevalence was lower ($p < 0.01$) in incisors and cuspids than in molars and premolars. A positive correlation with caries prevalence was found for the bleeding scores 6 weeks after debonding and *Lactobacillus* counts before debonding. Mutans streptococci counts, age, treatment duration, socioeconomic status and dietary habits showed no correlation with caries prevalence.

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It is well known that decalcifications are one of the risks of an orthodontic treatment [Wisth and Nord, 1977; Gorelick et al., 1982]. These incipient lesions, commonly known as white spot lesions, are situated on the buccal surfaces of teeth that normally show a low prevalence of caries [Øgaard et al., 1988]. White spot formation during orthodontic treatment has been attributed to the effect of prolonged accumulation and retention of bacterial plaque. The fixed appliances make conventional oral hygiene for plaque removal more difficult and adjacent to the brackets the clearance of plaque by saliva is also reduced. There seems to be a difference in progression rate between traditional caries formation and white spot lesions induced by deficient oral hygiene combined with fixed orthodontic appliances. The latter has a rather superficial and 'speedy' character and can become apparent within 1 month after placement of fixed appliances [Øgaard et al., 1988]. The formation of a 'normal' caries lesion is usually a slower process, which takes at least 6 months [Ekanayake and Sheiham, 1987].

Epidemiological investigations of a disease commonly start with studies of prevalence and incidence of the disease. After the extent and the distribution of the disease are investigated, the available information is then utilized in search for etiological factors and the nature of the disease. The reported prevalence of white spot lesions among orthodontically treated patients varies widely from 2 to

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Cytotoxicity and estrogenicity of Invisalign appliances

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Introduction: Our purpose was to study the in-vitro cytotoxic and estrogenic properties of Invisalign appliances (Align Technology, Santa Clara, Calif). **Methods:** Three sets, each consisting of a maxillary and a mandibular appliance, of as-received aligners were immersed in normal saline solution for 2 months. Samples of eluents were diluted to 3 concentrations (5%, 10%, and 20% vol/vol) and tested for cytotoxicity on human gingival fibroblasts and estrogenicity by measuring their effect on the proliferation of the estrogen-responsive MCF-7 breast cancer cells. All assays were repeated 4 times for each maxillary and mandibular set, and the results were analyzed with 2-way analysis of variance (ANOVA) with appliance and concentration serving as predictors at the .05 level of significance; differences among groups were investigated with the Tukey test. **Results:** There was no evidence of cytotoxicity on human gingival fibroblasts and no stimulation of proliferation of the MCF-7 cell line at any concentration, indicating no estrogenicity of aligner eluents. **Conclusions:** The use of Invisalign appliances did not seem to induce estrogenic effects under the conditions of this experiment. (*Am J Orthod Dentofacial Orthop* 2009;136:100-3)

The release of bisphenol-A (BPA) from dental polymeric applications has attracted the interest of many investigations over the past decade. Many articles have dealt with the potential estrogenicity of adhesives, composite resins, and polycarbonate products during the last 5 years.¹ The importance of identifying such incidents associated with dental resins is derived from the various effects assigned to BPA.²⁻⁵ Starting in the late 1980s, the search for effects of BPA on the human organism has become a national concern after several publications demonstrated activity at doses lower than the reference dose of 50 µg per weight set by the U.S. Environmental Protection Agency.⁶ This figure was calculated by dividing the lowest observed adverse effect level reported in the National Toxicology Program carcinogenesis bioassay (50 mg per kilogram)

by an uncertainty factor of 1000, presumably to secure safety for the human organism.

Nonetheless, in the late 1990s, studies reported increased prostate weights and other effects on the male reproductive system in mice exposed to levels of BPA below the safety standard (2 and 20 µg/kg).^{7,8} These articles were followed by many studies that found various effects, such as increased mammary gland tumors,⁹ precancerous lesions in prostates of neonatally exposed animals,¹⁰ development of hyperglycemia and insulin tolerance,¹¹ elevation of reactive oxygen species,¹² and oxidative stress.

The resultant turmoil on the hormonal endocrinologic disruptors provoked the investigation of estrogenic action of the full spectrum of polymeric materials used in everyday activities including plastic utensils and biomaterials for medical and dental applications. As a general rule, estrogenic action is confined to molecules with a double benzoic ring and that release BPA, which mimics the action of the female hormone estradiol.

In orthodontics, potential candidates for BPA release include plastic materials and auxiliaries such as adhesives and polycarbonate brackets and aligners. Although no BPA release and no estrogenicity have been reported for light-cured and chemically cured orthodontic adhesives,^{13,14} there is no documentation for Invisalign appliances (Align Technology, Santa Clara, Calif). These aligners are placed in the oral cavity for 22 hours per day for approximately 2 weeks to achieve gradual tooth movement.^{15,16} Whereas the in-vivo alterations of these appliances¹⁷ and treatment variables¹⁸ have been presented, the potential release of BPA has not been investigated.

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The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.

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Submitted, January 2009; revised and accepted, March 2009.

0889-5406/\$36.00

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doi:10.1016/j.ajodo.2009.03.006



Clinical Protocol for Phase 1 Orthodontic Treatment of the Mixed Dentition with Invisalign First aligners

Dr. Mark Garlington, Long Beach, CA

Dr. Mark Garlington is a board-certified orthodontist in solo practice in Long Beach, CA. He has a Bachelor's Degree in biology from UCLA and received both his DDS and his orthodontic specialty training from the University of Southern California. Dr. Garlington is a member of the Angle Society and the AAO. He and his wife are involved with several community programs in Long Beach, including the YMCA, BLAST, LBCC Foundation, Rotary, and Rancho Los Amigos Hospital. Dr. Garlington was one of only twenty doctors in North America invited to participate in the Invisalign First limited market release and has started or finished over sixty Invisalign First cases in the past 12 months. Dr. Garlington is a Diamond Level Invisalign Provider.

Summary

Efficient Phase 1 orthodontic treatment in our office means achieving our treatment goals in 6 to 9 months with no emergency visits, excellent oral hygiene maintained throughout treatment, and positive expectations generated in anticipation of Phase 2 treatment. Our practice consistently delivers efficient Phase 1 orthodontic treatment when we do the following: (1) use appliance systems that accomplish multiple tasks in parallel rather than in series, (2) streamline our appointment scheduling protocols into a consistent process, and (3) use digital dental technology to minimize chairtime. By using Invisalign First clear aligners and a digital workflow enabled through the iTero® intraoral scanner, our office is able to efficiently achieve excellent Phase 1 treatment results in mixed dentition patients with anterior spacing, anterior crowding, mesial drift from premature tooth loss, constricted dental arches, anterior dental crossbite, protruded incisors, and/or deep overbite.

Background

We are strong advocates of Phase 1 orthodontic treatment, and around 30% of our case starts are Phase 1 treatments. The main goal of Phase 1 treatment in our office is to prevent serious problems from developing, in order to simplify the Phase 2 treatment later. For example, inadequate space for the permanent teeth can lead to ectopic eruption or impaction that requires surgical exposure. Patients with excessive incisor protrusion may be prone to fractured teeth in the event of dental trauma. However, if the permanent teeth are able to erupt into a more normal position through Phase 1 arch development, we believe that the Phase 2 treatment time will be shorter than if the teeth are located in a more extreme position. Having the permanent teeth closer to a normal position also means that the gingival attachment supporting the teeth will be better, and the surrounding soft tissues will appear healthier and more balanced.

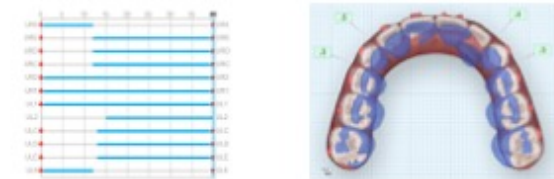
Early on, we used to promote serial extraction and enucleation of permanent premolars, but over the years, we have switched instead to expansion-based non-extraction treatments. Our typical Phase 1 treatment sequence used to consist of a fixed rapid maxillary expander and a lower Schwarz removable expander for arch development, followed by a 2x4 fixed appliance for dental alignment, and a lower lingual arch and upper bite plate as needed. For Class II patients, headgear and distalizing coil springs would also be added in order to reduce the severity of the Class II malocclusion for Phase 2. The main problem with this approach was that all the different appliances needed were often used sequentially, which increased the treatment time and made the patients and parents

much less enthusiastic about starting Phase 2 treatment afterwards.

Today, we still remove teeth for severe crowding cases, but our treatment efficiency has been significantly increased for mild to moderate Phase 1 treatments, by combining arch development and alignment into a single appliance system such as Invisalign First aligners. As a result, we no longer need to wait until after the arch development is completed to begin aligning the anterior teeth. We can accomplish both at the same time to avoid prolonging most Phase 1 treatments. This helps us reduce patient burnout, poor compliance, and negative feelings about Phase 2 treatment. We are also able to make the most out of the window of time when patients still respond well to their parents' guidance and to our treatment instructions. A single-phase orthodontic treatment once the patient becomes a teenager sometimes loses this advantage.

Several features of Invisalign First aligners for Phase 1 orthodontic treatment are unique to the product. First, the aligner staging pattern moves the molars first, followed by simultaneous expansion of the all the other teeth in the arch. Unlike traditional Phase 1 treatment where multiple appliances are used sequentially and the incisors are typically aligned later, Invisalign First aligners can align the incisors at the beginning of treatment, at the same time that the arches are widened. This distinction can lead to greater patient and parent satisfaction early on.

When applied to the posterior teeth, Invisalign's proprietary SmartStage™ technology produces the contacts and forces required for predictable dental arch expansion and good intercuspation between the arches. This is accomplished by minimizing molar tipping and inclination during dental expansion. Compensatory buccal root torque is also automatically added whenever the arches are widened.



Left: Staging pattern of the upper arch where the molars are moving first and expanding/rotating distally during aligners #1-12, followed by dental expansion of the C's, D's and E's during aligners #13-14. Incisor alignment starts at the very beginning of the aligner series. Buccal root torque compensation is also automatically added to the arch expansion. Right: The ClinCheck® set-up of the initial upper arch (in blue) superimposed over the treatment goal (in white).

The opinions expressed in this white paper are those of the author(s) and may not reflect those of Align Technology. The author was paid an honorarium by Align Technology in connection with the white paper.

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Advantages of Invisalign First aligners for Phase 1 Orthodontic Treatment

Dr. Terry Gruelle is an ABO certified orthodontist and graduated from the University of North Carolina. He maintains offices in Cincinnati, OH and Northern Kentucky and has treated over 4,000 patients with Invisalign aligners.

Having provided numerous treatments and seminars on Phase 1 orthodontics with Invisalign aligners since 2011, I had high expectations when I was asked to participate in the Invisalign First limited market release in 2017, where new aligner features specifically designed for Phase 1 orthodontic treatment were introduced. During this period, our offices started 14 Phase 1 orthodontic treatments with Invisalign First aligners (7 males and 7 females). The average age of the 7 female patients treated was 8 years 6 months. The average age of the 7 male patients was 9 years 11 months. Average treatment time was 44 weeks, including refinements and 7 day aligner wear time.

The table on the right summarizes the types of problems being addressed in our 14 Invisalign First patients.

| Malocclusion | N |
|---------------------|----|
| Crowding | 13 |
| Spacing | 4 |
| Narrow arches | 10 |
| Protrusion | 8 |
| Anterior cross bite | 2 |
| Space recapture | 4 |
| Deep bite | 12 |

The key features currently available with Invisalign First aligners include the following:

1. The new Eruption Compensation features make it possible to treat patients with aligners in both early and mixed dentition. Invisalign First is currently the only aligner product that provides upper and lower incisor eruption compensation. The spaces provided in the aligner allow the permanent teeth to erupt unobstructed, and they conveniently serve as a vertical stop once the teeth reach their desired position.
2. SmartStage™ technology applies newly-designed staging patterns to maximize dental arch expansion predictability. The staging patterns generated are very convenient because they are applied consistently to every Invisalign First case. This technology maximizes treatment efficiency by producing orthodontic forces that support the tooth movement needed for arch expansion. Targeted forces are applied to each segment of the arch with anchorage taken into consideration, and molars start moving first, followed by simultaneous expansion of the canines and all the posterior teeth. While this is happening, simultaneous alignment of the incisors occurs from the very beginning of treatment, so that young patients and their parents can begin to see their treatment results early on.

Figure 1: Visual representation of the molars move first staging pattern (default in clinical preferences)



3. For patients where anchorage control is less of a concern, the simultaneous staging pattern is also still available by request.

With simultaneous staging, all of the teeth move together.

Figure 2: Visual representation of the simultaneous staging pattern



4. As a complement to SmartStage technology for Phase 1 treatment, new Optimized Expansion Support attachments are now available. These attachments are automatically placed and sized for maximum biomechanical advantage during dental expansion. Arch expansion devices will usually tip the crowns buccally, so counter-moments for buccal root torque are needed to create bodily movement without tipping. With the new Expansion Support Attachments, the surface area needed to create a proper counter-moment is calculated for each individual tooth and automatically built into the attachment design.
5. To improve aligner retention on short clinical crowns, new Optimized Retention attachments are also available. These attachments are automatically sized and positioned based on the available buccal crown surface of the patient's teeth. Doctors who prefer using traditional round or rectangular attachments for aligner retention can still request them, but the new Optimized Retention attachments are much more convenient and consistent with regards to the orientation of the desired undercut.

Figure 3: Visual representation of the optimized expansion support and retention attachments demonstrating variable size based on the buccal surface area

Results



The opinions expressed in this white paper are those of the author(s) and may not reflect those of Align Technology. The author was paid an honorarium by Align Technology in connection with the white paper.

Color fading of the blue compliance indicator encapsulated in removable clear Invisalign Teen® aligners

Timm Cornelius Schott^a; Gernot Göz^b

ABSTRACT

Objective: To evaluate the color fading in aqueous solutions of the blue dot wear-compliance indicators of the Invisalign Teen® System outside the oral cavity.

Materials and Methods: The compliance indicators in the Invisalign Teen aligners were tested for color resistance in various aqueous models with no saliva involved.

Results: Color fading was observed as a function of time, pH, and temperature while compliance indicators were stored in drinking water or sour soft drinks and in conjunction with the use of cleaning tablets and a dishwasher. The findings of color fading were consistent with the color changes observed when the aligners were being worn by patients. Color fading, notably as observed in connection with acidic soft drinks and cleaning techniques, introduces uncertainty into the assessment of actual patient compliance, as reflected by the fading colors of compliance indicators.

Conclusion: Compliance indicators are not immune to simple intentional or unintentional manipulations. Therefore, they can best show an estimate of wear time but cannot be recommended as objective wear-time indicators. (*Angle Orthod.* 2011;81:185–191.)

KEY WORDS: Removable aligners; Invisalign® Teen; Compliance indicator; Encapsulated dye

INTRODUCTION

Compliance is a mandatory for effective treatment with a removable orthodontic appliance.^{1,2} Studies of self-reported wear times as compared to the results of clinical assessment have shown that reliable information was obtained in only 43% of patients.³ A total of 140 patients with a mean age of 12.7 years were surveyed by questionnaire.⁴ The majority expressed a desire to wear their appliances only at night, and they did not wish to have wear times prescribed. When patients were informed that their headgear wear times were being recorded, they did tend to wear the headgear more regularly but still fell short of the actual instructions given.¹

Align Technology recently started distributing a compliance indicator that was designed for use on

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Accepted: August 2010. Submitted: May 2010.

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young patients treated with the Invisalign® Teen system.⁵ According to the manufacturer, the compliance indicator uses the food dye Erioglaucine disodium salt, which is encapsulated in the clear Invisalign Teen aligner and is released from the polymer in the presence of oral fluid.⁶ The amount of dye loss will correspond with the amount of time the aligner was worn in the oral cavity. Two different blue dot wear indicators (fast and slow fading) are used to ensure that individual patients' different saliva compositions are appropriately accounted for. The different color fading is based on the different amount of the diffused dye determined by the pore sizes of the polymer. The blue dots are embedded in the vestibular part of the molar segments of the aligners (Figure 1). Wear time is determined by assessing the way in which the compliance indicators change color as the aligner is worn. The clinician is required to evaluate five potential color changes (ranging from dark blue/dark blue to clear/clear) to obtain a graphic representation of the wear time.

In a study of 14 patients who were prescribed Invisalign Teen® with clear aligners and embedded color indicators, it was concluded that the service times determined from the compliance indicators showed good agreement with the number of service hours reported by the patients. The positive assessment of compliance based on compliance indicators, however,

Invisalign®—15 years later, has it become a real alternative to fixed appliances?

J.-F. Chazalon

Specialist certified in DFO, private practice

ABSTRACT

After 15 years of existence in France, Invisalign® has become a credible alternative to treatment with attachments. This article aims to review the latest developments made by Invisalign® and the results achieved at the clinical level. In our review, which includes clinical case photographs, we explore the possibilities of the system, including expected results, limitations, and associated precautions.

KEY WORDS

Invisalign®, ClinCheck Aligners, evaluation tooth movements, unwanted movements

INTRODUCTION

One of the constants of the evolution of orthodontic devices is the search for an esthetic device which, in patient language, translates to an “unseen device.”

This request for discretion occurred initially with the appearance of ceramic brackets and then lingual orthodontic devices. Another track emerged 15 years ago when thermoformed splints or aligners were used, dental displacement was no longer being performed by brackets and arches but by the successive change facilitated by transparent thermoformed splints or aligners.

If the esthetic criteria and the notion of comfort^{5,6,7} have been major arguments in the use of aligners to the detriment of the limitations of the technique, the evolution

of materials and the contribution of digital technologies have revived the use of this type of « plastic » orthodontics, particularly with Invisalign being developed by Align Technology (Santa Clara, California) in 1999 and from 2001 in France.

In the study on Invisalign, we find two distinct parts that are key to system and the control of which is crucial to the success of our treatments:

- The treatment tool, the alignment splint, and aligners are responsible for dental displacement
- The tool to be decided on is the ClinCheck, a proprietary software application that visualizes the stages of treatment until the final result and this

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*Article received: 04-02-2016.
Accepted for publication: 10-06-2016.*

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Article available at <https://www.jdao-journal.org> or <https://doi.org/10.1051/odfen/2016027>



Align Technology Introduces Invisalign G3

New Innovations Represent Significant Leap Forward in Clear Aligner Therapy

SAN JOSE, Calif., Aug 16, 2010 (GlobeNewswire via COMTEX News Network) -- Align Technology, Inc. (Nasdaq:ALGN) today announced the launch of Invisalign(R) G3, the most significant collection of new features and innovations in the company's history. Invisalign G3 is engineered to deliver even better clinical results, with new aligner and software features that make it easier to use Invisalign with Class II and Class III patients, new SmartForce(TM) features designed for increased predictability of certain tooth movements, and simpler, more intuitive software to streamline treatment planning and review.

Invisalign G3 builds on a new and improved feature set introduced to the Invisalign product line last fall. "The innovations in Invisalign G3 really get at the heart of what doctors have been asking for from Invisalign treatment," said Sheila Tan, Align vice president, marketing and chief marketing officer. "With technology and tools that are designed to expand the clinical scope of Invisalign, deliver greater predictability across most clinical situations, and make treatment planning more efficient -- Invisalign G3 represents a tremendous leap forward in Invisalign innovation and demonstrates how we leverage our technology to deliver the clinical outcomes doctors expect."

Features that make it easier to use Invisalign to treat Class II and Class III patients

The treatment of Class II/III malocclusion often requires the use of interarch elastics to provide anchorage control. Previously, doctors had to manually cut the aligners to accommodate the use of elastics, which may have discouraged the use of Invisalign in these cases. Invisalign G3 addresses this barrier with new Precision Cuts, which are doctor-prescribed pre-cuts in the aligners that accommodate the use of elastics. Using a new drag-and-drop interface in ClinCheck 3.0 software, doctors have the flexibility to specify the placement and the type of Precision Cuts on the aligners, making it easier for doctors to use Invisalign.

"I am very excited about the new features and innovations in Invisalign G3, particularly Precision Cuts," said Dr. Sam Daher, an orthodontist practicing in Vancouver, BC. "It's a significant enhancement to what I do in the office every day and will make it even easier to use Invisalign on complex cases."

SmartForce(TM) features for greater predictability of tooth movements

SmartForce features, such as the Optimized Attachments introduced last fall, are attachments and aligner features that are engineered to deliver the forces needed to achieve predictable tooth movements. Based on biomechanical principles, SmartForce features are customized to each tooth using advanced virtual modeling, and are positioned precisely to deliver the proper forces.

New SmartForce features in Invisalign G3 include an Optimized Rotation Attachment for bicuspid (previously available only for cuspids), a new Power Ridge(TM) feature for lower anteriors (previously available only for the upper arch), and a Lingual Power Ridge feature for upper anteriors. A new variation of the Optimized Rotation Attachment is also being introduced to address clinical situations where placement of the attachment may have previously been difficult.

Intuitive features and drag-and-drop interfaces in ClinCheck 3.0 and the Invisalign Doctor Site streamline treatment planning

In addition to clinical tools and enhancements, Invisalign G3 streamlines the overall treatment planning process. Specifically, a significant evolution of the ClinCheck software makes it easier and more intuitive for doctors to create and modify Invisalign treatment plans. One of the most exciting improvements is the addition of drag-and-drop interfaces for ordering Precision Cuts and attachments, providing doctors with new tools designed to make it easier and more efficient for them to develop and review their treatment plans.

The Invisalign Doctor Site (formerly Virtual Invisalign Practice or "VIP") is a secure web site where doctors access Invisalign patient records, review and approve ClinCheck treatment plans, view patient account status, order treatment supplies, and more. A significant redesign of the site not only makes it simpler and more intuitive to use, but also consolidates all of a patient's Invisalign records and treatment tasks together in one location for easy access. The Invisalign Doctor Site also introduces a new online prescription form that is integrated with the doctor's clinical preferences.

The improvements and innovations in Invisalign G3 also include new clinical preferences, improved staging for interproximal

Traitement des classes II pour les patients au cours de la croissance par gouttières thermoformées : quel protocole ?

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(Reçu le 7 janvier 2019, accepté le 1^{er} février 2019)

MOTS CLÉS :

Aligneurs /
Classe II /
Croissance /
Vertèbres cervicales /
Protocole de traitement
des classes II /
Potentiel auxologique

KEYWORDS:

Aligners /
Class II /
Growing patient /
Cervical vertebrae /
Best protocol /
Auxologic potential

RÉSUMÉ – Introduction : Les classes II squelettiques, fréquemment associées à une rétromandibulie et un surplomb supérieur à 2 mm, entraînent un préjudice fonctionnel et esthétique que le traitement orthodontique se doit de corriger. L'objectif de cet article est de décrire un protocole de traitement par aligneurs, chez le patient en cours de croissance, en fonction de l'importance de la classe II et du stade de maturité de ses vertèbres cervicales. **Matériels et méthodes :** Au travers de cas cliniques, cet article va présenter trois approches thérapeutiques différentes en fonction du stade de croissance. **Résultats :** L'étude du potentiel auxologique et la détermination de l'âge osseux (analyse radiologique de la maturation des vertèbres cervicales) vont permettre de déterminer le moment le plus opportun pour traiter la classe II et l'attitude thérapeutique la plus appropriée en fonction du stade de croissance. **Discussion :** Ce prérequis avant traitement est donc essentiel afin d'adapter un protocole clinique individualisé à chaque patient. En ce sens, les aligneurs sont des dispositifs qui répondent bien à cet impératif, car ils sont personnalisables au vu de la thérapeutique et du plan de traitement envisagés par le praticien. Toutefois, il faut garder à l'esprit qu'une bonne observance est indispensable, quelle que soit la thérapeutique envisagée.

ABSTRACT – Treatment of class II for growing patients by clear aligners: which protocol? Introduction: Skeletal class II, frequently associated with retromandibular and overjet > 2 mm, lead to functional and aesthetic damage, that orthodontic treatment has to correct. The aim of this article is to describe a treatment protocol by aligners for class II growing patients according to the value of the class II and the maturity state of cervical vertebrae. **Materials and methods:** Through clinical cases, this article will present three different therapeutic approaches depending on the growth state. **Results:** The study of the auxologic potential and determination of the bone age (radiological analysis of the maturation of the cervical vertebrae) will allow to determine the best moment to treat class II and the most appropriate therapeutic attitude according to growing state. **Discussion:** This study before treatment is essential to adapt an individualized clinical protocol to each patient. In this way, aligners are devices that respond well to this imperative because they are customizable in view of the strategy and the treatment plan considered by the practitioner. We must keep in mind, however, that with any therapy, it is essential to ensure good patient compliance.

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Periodontal health in teenagers treated with removable aligners and fixed orthodontic appliances

Parodontale Gesundheit von Teenagern mit herausnehmbaren Alignern und festsitzenden kieferorthopädischen Apparaturen

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Abstract

Objectives. The purpose of this study was to explore the microbiological and periodontal changes occurring in adolescents during 12 months of orthodontic therapy with removable aligners and with fixed appliances.

Material and methods. During the years 2012–2013, 50 teenagers aged 10–18 years with similar initial orthodontic conditions participated in this trial in a university clinic in northern Italy. After receiving professional oral hygiene and instructions on a standardized oral hygiene protocol, the adolescents were randomly assigned to either orthodontic treatment with traditional fixed brackets (n=25) or to treatment with Invisalign® aligners (n=25). Subgingival microbiological samples, probing depth (PD), plaque index (PI), and bleeding on probing (BOP) were obtained and documented from the mesiovestibular subgingival sulcus of the upper right first molar and left central incisor at the beginning of treatment and 3, 6, and 12 months later. Compliance with oral hygiene procedures, full mouth plaque score (FMPS), and full mouth bleeding score (FMBS) were assessed at the beginning of treatment and 12 months later. Two sample independent t-tests and the χ^2 test were used to study whether the indices of periodontal health differed in the teenagers due to the experimental conditions.

Results. None of the patients was positive for the periodontal anaerobes analyzed. The PI, PD, BOP, FMPS, and FMBS scores were

Zusammenfassung

Studienziel. Gegenstand dieser Untersuchung waren die mikrobiologischen und parodontalen Veränderungen bei Jugendlichen über 12 Behandlungsmonate mit herausnehmbaren Alignern oder festsitzenden Apparaturen.

Methode. Die Studie umfasst 50 Teenager (10–18 Jahre) mit vergleichbaren kieferorthopädischen Indikationen, behandelt in den Jahren 2012 und 2013 an einer norditalienischen Universitätsklinik. Nach einer professionellen Hygienesitzung und Unterweisung in einem standardisierten Mundhygieneverfahren erfolgte nach dem Zufallsprinzip die Zuordnung der Jugendlichen zu einer von 2 Behandlungsgruppen mit traditionellen Klebebrackets (n=25) oder Invisalign®-Schielen (n=25). Zu Behandlungsbeginn sowie 3, 6 und 12 Monate danach erfolgten mikrobiologische Probenentnahmen im Oberkiefer aus dem mesiovestibulären Sulcusbereich des rechten ersten Molaren und linken mittleren Schneidezahns sowie eine Beurteilung auf Sondiertiefen, Plaqueindex und provozierte Blutungen. Außerdem beurteilten wir zu Behandlungsbeginn und 12 Monate danach die Hygienesziplin sowie die Gesamtindizes FMPS (Full Mouth Plaque Score) und FMBS (Full Mouth Bleeding Score). Zweistichproben-t-Tests für unabhängige Stichproben und der χ^2 -Test dienten dem Auffinden von Gruppenunterschieden bei den parodontalen Indizes.

Resultate. Tests auf 4 anaerobe Parodontalkeime waren für alle Patienten negativ. Die Invisalign®-Gruppe zeigte gegenüber der Bracket-Gruppe signifikant niedrigere Werte für Plaqueindex, Sondiertiefen, provozierte Blutungen sowie FMPS- und FMBS-Werte. Auch die Hygienesziplin war in der Invisalign®-Gruppe signifikant besser.

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Received: 2 May 2014; accepted: 28 October 2014;
published online: 2 May 2015


J Orofac Orthop 2015; 76:240–250
DOI 10.1007/s00056-015-0285-5

RESEARCH

Open Access



Salivary levels of cariogenic bacterial species during orthodontic treatment with thermoplastic aligners or fixed appliances: a prospective cohort study

Iosif Sifakakis¹, William Papaioannou², Aikaterini Papadimitriou³, Dimitrios Kloukos^{3,5}, Spyridon N. Papageorgiou⁴ and Theodore Eliades^{4*} 

Abstract

Background: Fixed orthodontic appliances might be associated with intraoral adverse effects on enamel, due to plaque accumulation and their colonization by oral microbes. At the same time, the demand for esthetic alternatives to orthodontic treatment, like thermoplastic aligners, is growing. However, thermoplastic aligners may behave differently intraorally than fixed appliances in terms of bacterial colonization and biofilm formation. Therefore, the aim of this prospective cohort study was to assess the salivary prevalence of the cariogenic bacteria *Streptococcus mutans*, *Lactobacillus acidophilus*, and *Streptococcus sanguinis* among adolescents treated orthodontically with thermoplastic aligners or fixed appliances.

Methods: Thirty adolescent patients (17 girls/13 boys; mean age 13.8 years old) were assigned to treatment with either (i) self-ligating fixed appliances with nickel-titanium archwires or (ii) aligners constructed from clear transparent polyethyleneterephthalat-glycol copolyester (PET-G) thermoplastic sheets. Whole stimulated saliva was collected from each patient at three time points: at baseline (before bonding and initiation of orthodontic therapy or before insertion of the thermoplastic aligners), after 2 weeks, and after 1 month. A simplified plaque index, a simplified gingival index, and the decayed, missing, and filled teeth (DMFT) index were assessed from the clinical examination of the patients. Microbiological analysis of salivary bacteria was performed by quantitative polymerase chain reaction, followed by descriptive and inferential statistics at the 5% level.

Results: Although patients treated with aligners had significantly lower plaque and gingivitis scores throughout treatment compared to patients treated with fixed appliances, no significant difference could be found between the *S. mutans* counts of the two groups at any time through treatment ($P > 0.05$). On the other hand, patients treated with aligners had significantly lower salivary *S. sanguinis* counts at all time points than patients treated with fixed appliances ($P < 0.05$). Finally, almost no *L. acidophilus* were identified in the collected saliva samples in either of the treated samples.

Conclusions: Within the limitations of this study, there were no differences in the salivary counts of *S. mutans* or *L. acidophilus* among adolescent patients treated for 1 month with thermoplastic aligners or self-ligating appliances. On the other hand, patients treated with aligners had lower salivary levels of *S. sanguinis* compared to those treated with self-ligating appliances.

Keywords: Aligners, Fixed appliances, *S. mutans*, *S. sanguinis*, *L. acidophilus*

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Effects of Invisalign® treatment on speech articulation

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Available online: 17 July 2019

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Keywords

Articulation
Speech intelligibility
Aligner
Treatment effects

■ Summary

Objectives > To determine the effects of Invisalign® aligners on patients' abilities to articulate consonants.

Materials and methods > Thirty patients undergoing active two-arch Invisalign® treatment were examined. Patients were recorded reading the rainbow passage (a passage with every phoneme represented), once with the trays inserted and once with the trays removed. The recordings were analysed by a speech pathologist for misarticulation of consonant phonemes.

Results > Misarticulation of consonants was significantly associated with the Invisalign® aligners inserted as based on the McNemar's statistical test ($P = 0.008$). The fricative alveolar consonant /z/ was found to be the most impacted by the trays, followed by the consonant /s/ ($P = 0.016$). The consonant /sh/ was not shown to be affected by the Invisalign® aligners.

Conclusions > Invisalign® aligners do have an impact on the articulation of consonants. Fricative alveolar consonants were the primary phonemes impacted. Due to the fact that the efficacy of Invisalign® treatment is based primarily on compliance and that speech impairment may interfere with compliance, the information presented in this study should be conveyed to the patient before the initiation of Invisalign® treatment.

Mots clés

Articulation
Intelligibilité de la parole
Aligneur
Effets thérapeutiques

■ Résumé

Effets du traitement Invisalign® sur l'articulation de la parole

Objectifs > Déterminer les effets des aligneurs Invisalign® sur la capacité des patients à articuler les consonnes.

Matériels et méthodes > Trente patients sous traitement Invisalign® actif des deux arcades dentaires ont été examinés. Les patients ont été enregistrés en train de lire le passage Rainbow (un passage dans lequel chaque phonème est représenté), une fois en portant les gouttières en

Comparison of Short-Term Oral Impacts Experienced by Patients Treated with Invisalign or Conventional Fixed Orthodontic Appliances

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Significance of the Study

- This study was aimed at comparing the oral health-related quality of life of patients during thermo-plastic clear aligner therapy (Invisalign®) and conventional fixed orthodontic appliances using a previously validated questionnaire.
- Clear aligner therapy appears to be tolerated better, but in the short term affects pronunciation and speech delivery.

Keywords

Invisalign · Braces · Fixed appliance therapy · Dentistry · Orthodontics · Patients · Oral impacts · Oral health-related quality of life

Abstract

Objectives: Our objective was to test the hypothesis that thermoplastic clear aligners (Invisalign®; Align Technology, Santa Clara, CA, USA) are more pleasant for patients than conventional fixed orthodontic appliances. **Subjects and Methods:** This was an observational retrospective study in which subjects were matched for age, treatment modality, and the treating orthodontist. A total of 60 adult patients (30 in the Invisalign group and 30 in the conventional buccal fixed appliance group) who met the inclusion criteria completed a validated self-reporting questionnaire, rating their experience after appliance activation in regard to oral im-

pact experience and satisfaction of both treatment modalities. Categorical variables were compared using the χ^2 test, Fisher's exact test, and the Z test. Continuous variables such as pain level and age were analyzed using the 2-sample t test. **Results:** Patients on clear aligner therapy reported significantly more difficulty in speech ($p = 0.035$) necessitating change in speech delivery ($p = 0.003$). In addition, they reported better chewing ability ($p < 0.001$), no restrictions on amounts or types of food ($p = 0.02$), and less mucosal ulcerations ($p = 0.01$). Effects on daily routine, use of analgesics, and overall treatment satisfaction were not significantly different between the 2 groups. **Conclusion:** Clear aligner therapy is not necessarily more pleasant, but it is more tolerable as it satisfies patient needs over food consumption and absence of mucosal ulcerations. However, clear aligners affect pronunciation and speech delivery in the short term.

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Self-ligating *versus* Invisalign: analysis of dento-alveolar effects

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Summary

Self-ligating *versus* Invisalign: analysis of dento-alveolar effects.

Aim. *The aim of this study was to evaluate the changes in the transverse dimension and the perimeter of the maxillary arch produced by low friction self-ligating brackets TIME 3 compared to the Invisalign technique.*

Materials and methods. *Both the self-ligating sample and the Invisalign group were composed of 20 subjects, evaluated at the beginning (T0) and at the completion of therapy (T1). All subjects presented a Class I malocclusion with mild crowding in a permanent dentition, without craniofacial anomalies, missing teeth or a history of orthodontic treatment. Dento-alveolar measurements were made on the maxillary dental casts at T0 and T1. Significant differences between the treated groups were assessed with Independent Samples t test ($p < 0.05$).*

Results. *Statistically significant differences between self-ligating sample and Invisalign group were recorded for CWC, FPWF, FPWL, SPWF, SPWL, and AP measurements. No significant changes were found for CWL, MWF, MWL, and AD values. There was not a statistically significant difference between the treatment durations of the groups: 1.8 years for both patients. These data suggest that Invisalign treatment cannot be somewhat faster than fixed appliances. Moreover the final occlusion might not be as ideal.*

Conclusions. *The low friction self-ligating system produced statistically significant different outcomes in the transverse dento-alveolar width and the perimeter of the maxillary arch during treatment when compared to Invisalign technique.*

Key words: self-ligating, crowding, Invisalign.

Introduction

The Invisalign system (Align Technology, Santa Clara, Ca, USA) an esthetic orthodontic treatment with removable, clear semielastic polyurethane aligners has become more often a common treatment choice since its first appearance in 1997. This computer-aided modeling technique can fabricate numerous aligners to move teeth with relative precision to obtain a good occlusion. These aligners are made from a thin, transparent plastic that fits over the buccal, lingual/palatal and occlusal surfaces of the teeth. They conventionally are worn for a minimum of 20 hours per day and are changed sequentially every two weeks. Invisalign has been indicated by its manufacturer to be used in adults and adolescents who have fully erupted permanent dentitions (1,2).

Align Technology provides guidelines for the types of malocclusion that can be successfully treated with Invisalign. Cases for which Invisalign is indicated include mild to moderate crowding (1-6 mm), mild to moderate spacing (1-6 mm), nonskeletal constricted arches, and relapse after fixed appliance therapy (3). The manufacturer claims that Invisalign can effectively perform the following interorthodontic movements: space closure, alignment after interproximal reduction, dental expansion, flaring, and distalization (4). The Invisalign system has become a popular treatment choice for clinicians because of the esthetics and comfort of the removable clear aligners compared with traditional appliances.

One of the more commonly encountered types of patients who request Invisalign treatment are those who have previously received orthodontic treatment using fixed appliances and do not want fixed appliances for their present orthodontic treatment. Esthetic concerns during follow-up orthodontic treatment may be a significant factor, with many patients not wanting to show metal or partially clear fixed appliances with arch wires when they smile. Another group of patients who want Invisalign are teenagers who wish to improve their esthetics, but are not interested in having the appearance of fixed appliances (5).

To this date, little clinical research has been published to comprehensively study the effectiveness of Invisalign treatment (1-3). The lack of such objective information on this product has made it difficult for clinicians to objectively characterize the efficacy of Invisalign as compared to fixed appliances.

In the last 20 years self-ligating brackets have undergone a renaissance because the concept of self-ligation having been pioneered in 1930s. Self-ligating brackets have a built-mechanism to close off the edgewise slot, obviating the need for elastomerics or steel ties to secure the archwire in the bracket slot. The chief advantages of self-ligating system over conventional appliances are claimed to include reduced friction, more robust ligation, more efficient tooth movement and sliding mechanics that can reduce treatment time (6,7).

Comparative time efficiency of aligner therapy and conventional edgewise braces

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ABSTRACT

Objective: To compare the time efficiency of aligner therapy (ALT) and conventional edgewise braces (CEB) based on large samples of patients treated by the same highly experienced orthodontist, with the same treatment goals for both groups of patients.

Materials and Methods: The retrospective portion of the study evaluated 150 CEB patients who were matched, based on mandibular crowding and number of rotated teeth, to 150 ALT patients. All records were obtained at one orthodontist's office. All of the patients had mild-to-moderate Class I malocclusions (≤ 5 mm incisor crowding) and were treated nonextraction. Age, gender, total treatment time, total number of appointments, types of appointments, materials used, mandibular crowding, and number of rotated teeth were recorded from the patients' records. The prospective portion of the study timed the various types of appointments for both treatments with a stopwatch.

Results: Compared to ALT, CEB required significantly ($P < .01$) more visits (approximately 4.0), a longer treatment duration (5.5 months), more emergency visits (1.0), greater emergency chair time (7.0 minutes), and greater total chair time (93.4 minutes). However, ALT showed significantly ($P < .01$) greater total material costs and required significantly more total doctor time than CEB ($P < .01$).

Conclusions: Whether the greater time efficiency of ALT offsets the greater material costs and doctor time required depends on the experience of the orthodontist and the number of ALT case starts. (*Angle Orthod.* 2014;84:391–396.)

KEY WORDS: Efficiency; Aligner therapy; Chair time; Doctor time

INTRODUCTION

Time efficiency is an important outcome measure for private practice orthodontists because it often determines the type of treatment modality that is used. For example, self-ligating brackets have been shown to be more efficient than conventional edgewise brackets in terms of total chair time and treatment duration.^{1–4}

For the orthodontist, it is just as important to base treatment efficiency on total doctor time, total chair time, and material costs.

In 1999, Align Technology introduced a new form of treatment, which consists of a series of computer-generated, clear, and removable aligners.⁵ Esthetics has been shown to be the major concern of patients who elect to undergo the clear aligner treatment (ALT).⁶ Other benefits include the ability to remove the aligners to eat, the enhanced ability to brush and floss, and treatment that does not involve metal that can irritate the cheeks and gums.⁷ The total number of appointments required for ALT cases, the percentages of patients requiring midcourse corrections, and the number of patients requiring fixed appliances all depend on the pretreatment complexity of the treatments.⁸

It is presently unclear how—in terms of treatment efficiency—ALT compares to conventional edgewise braces (CEB) treatment. The present study was designed to evaluate ALT and CEB based on patients treated by one highly experienced orthodontist, who had the same objectives for all patients. The study goes beyond previous evaluations of efficiency by (1)

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Accepted: October 2013. Submitted: June 2013.

Published Online: November 18, 2013

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Efficiency, effectiveness and treatment stability of clear aligners: A systematic review and meta-analysis

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Structured Abstract

Objectives: The objective of this study was to perform a systematic review of the orthodontic literature with regard to efficiency, effectiveness and stability of treatment outcome with clear aligners compared with treatment with conventional brackets.

Methods: An electronic search without time or language restrictions was undertaken in October 2014 in the following electronic databases: Google Scholar, the Cochrane Oral Health Group's Trials Register, Scopus, CENTRAL, MEDLINE via OVID, EMBASE via OVID and Web of Science. We also searched the reference lists of relevant articles. Quality assessment of the included articles was performed. Two authors were responsible for study selection, validity assessment and data extraction.

Results: Four controlled clinical trials including a total of 252 participants satisfied the inclusion criteria. We grouped the trials into four main comparisons. One randomized controlled trial was classified as level 1B evidence, and three cohort studies were classified as level 2B evidence. Clear aligners appear to have a significant advantage with regard to chair time and treatment duration in mild-to-moderate cases based on several cross-sectional studies. No other differences in stability and occlusal characteristics after treatment were found between the two systems.

Conclusions: Despite claims about the effectiveness of clear aligners, evidence is generally lacking. Shortened treatment duration and chair time in mild-to-moderate cases appear to be the only significant effectiveness of clear aligners over conventional systems that are supported by the current evidence.

KEYWORDS

clear aligner, comparative effectiveness research, orthodontic appliances, systematic review, treatment outcome

1 | INTRODUCTION

The first clear aligner was introduced by Kesling¹ in the early 1940s. However, it did not gain much popularity because of scepticism and the lack of promotion at that time. With the development of dental materials and 3D technology, clear aligners became more popular.

Many advantages have been claimed of this type of appliance over conventional edgewise appliances. The greatest advantage of this appliance, compared to fixed orthodontic appliances, is improved aesthetics and comfort for the patient. For these reasons, patients who

care about their appearance or their speech are good candidates for treatment with clear aligners. However, clear aligners have some disadvantages, including higher costs and the inability to treat certain types of malocclusion.²⁻⁴

Few clinical studies have been published that adequately assessed the effectiveness of treatment with clear aligners leaving uncertainty among clinicians about the effectiveness of the appliance. McNamara and others stated that more studies are needed to expand the understanding of the clinical applicability of clear aligners.²⁻⁴ Additionally, there is a paucity outcome studies in a case-controlled research design.

Has Invisalign improved? A prospective follow-up study on the efficacy of tooth movement with Invisalign

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Introduction: The purpose of this research was to provide an update on the accuracy of tooth movement with Invisalign (Align Technology, Santa Clara, Calif). **Methods:** This prospective clinical study included 38 patients treated with Invisalign Full or Invisalign Teen. All teeth, from the central incisor to the second molar, were measured on digital models created from intraoral scans. Predicted values were determined by superimposing the initial and final ClinCheck models, and achieved values were determined by superimposing the initial ClinCheck models and the digital models from the posttreatment scans. Individual teeth were superimposed with a best-fit analysis and measured using Compare software (version 8.1; GeoDigm, Falcon Heights, Minn). The types of tooth movements studied were a mesial-distal crown tip, buccal-lingual crown tip, extrusion, intrusion, and mesial-distal rotation. **Results:** The mean accuracy of Invisalign for all tooth movements was 50%. The highest overall accuracy was achieved with a buccal-lingual crown tip (56%), whereas the lowest overall accuracy occurred with rotation (46%). The accuracies for mesial rotation of the mandibular first molar (28%), distal rotation of the maxillary canine (37%), and intrusion of the mandibular incisors (35%) were particularly low. **Conclusions:** There was a marked improvement in the overall accuracy; however, the strengths and weaknesses of tooth movement with Invisalign remained relatively the same. (Am J Orthod Dentofacial Orthop 2020;158:420-5)

In 2009, Kravitz et al¹ conducted the first prospective clinical study on Invisalign (Align Technology, Santa Clara, Calif) to evaluate its efficacy. Prior published data included case reports, material studies, technical articles, editorials, surveys, studies comparing Invisalign to conventional fixed appliances, and a systematic review, none of which provided scientific evidence regarding the efficacy or limitations of Invisalign.²⁻²³ Ten years after Invisalign was introduced, orthodontists were just beginning to quantify how well it moved teeth.

The landmark study by Kravitz et al¹ evaluated the accuracy of anterior tooth movements with Invisalign. Measurements were made by superimposing the predicted and achieved ClinCheck digital models over

the stationary premolars and molars, using ToothMeasure, Align's tooth measurement software.²⁴ The most accurate movement was lingual constriction (47%), and the least accurate movements were incisor extrusion (18%) and mandibular canine rotation (28%). The overall mean accuracy of Invisalign was 41%.

In a second study, using the same sample and methodology, Kravitz et al²⁵ specifically evaluated the influence of interproximal reduction (IPR) and ellipsoid attachments on canine rotation. The mean accuracy of this rotation with Invisalign was 36%. The authors reported that canines which received IPR achieved the highest accuracy (43%). Most importantly, the accuracy of canine rotation significantly dropped with rotational movements greater than 15°.

Since these 2 studies were published, significant contributions have been made, further evaluating the efficacy of tooth movement with Invisalign.

In 2012, Krieger et al²⁶ also evaluated anterior tooth position with Invisalign, but they studied different parameters. Rather than assessing individual tooth movements, the authors evaluated arch length, intercanine distance, overbite, overjet, and midlines by comparing initial and final plaster casts, which were measured with digital calipers. They provided a general

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All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.

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Submitted, June 2019; revised and accepted, October 2019.

0889-5406

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<https://doi.org/10.1016/j.ajodo.2019.12.015>

One Phase versus Two Phase Treatment in Mixed Dentition: A Critical ReviewM Suresh¹, Akurathi Ratnaditya², Vivekanand S Kattimani³, Shameem Karpe⁴**Contributors:**

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How to cite the article:

Suresh M, Ratnaditya A, Kattimani VS, Karpe S. One Phase versus two phase treatment in mixed dentition: A critical review. J Int Oral Health 2015;7(8):144-147.

Abstract:

The mixed dentition is the developmental period after the permanent first molars and incisors have erupted, and before the remaining deciduous teeth are lost. Phase I treatment is usually done early in this period. Mixed dentition treatment goals often focus on skeletal rather than dental correction. To design a treatment plan, the clinician must understand the growth and development patterns, and the known effects of the chosen treatment modality. Jaw growth affects orthodontic treatment, usually favorably, but sometimes unfavorably. When and how much growth will occur is completely unpredictable. However, we know some useful facts about jaw growth in the mixed dentition. The two areas that remain controversial in the orthodontic literature are the treatment of crowding and of Class II malocclusions in the mixed dentition. Is there a benefit to early treatment for these problems? This question has yet to be fully answered by researchers. Hence, we planned for review of all available literature to come to a consensus about preventive or interceptive orthodontics or in other words Phase 1 and Phase 2 treatment. The clinician can diagnose and intercept certain developing problems with early treatment. Many other cases should be supervised, but not treated until the permanent teeth are in place. We must base our decision to treat on experience, knowledge of growth and dental development, and research.

Key Words: Adolescent, children, interceptive orthodontics, mixed dentition, orthodontic treatment, preventive orthodontics, primary dentition

Introduction

"Timing is everything" holds best when it comes to treatment planning in orthodontics. It has been suggested that almost all types of malocclusion could be benefited from early treatment.

The effectiveness of the intervention depends on malocclusion. The main reason for the controversy seems to be our present knowledge about the timing of treatment; which is largely based on clinical experience with various clinical approaches and traditions of orthodontic practice. Scientific evidence is limited and few studies have specifically targeted questions about the effects of early treatment.¹ This article gives an overview and consensus of the literature to the clinician regarding the various studies related to the debate on "one phase versus two phase treatment in mixed dentition."

A thorough literature review regarding the different schools of thought in the orthodontic management of mixed dentition period searched in the search engine (Viz: Google Scholar, Pubmed, Hinari, and various Indexing and open access sites) with key word of preventive,¹⁻⁴ interceptive,⁴⁻¹¹ mixed dentition,¹²⁻¹⁸ children orthodontic management,¹⁹⁻²⁷ one phase, two-phase orthodontic treatment²⁸⁻³⁰ in both title and abstract field. All articles thoroughly reviewed by the authors to come to a consensus regarding the role of pedodontist, oral surgeon, and orthodontist in multispecialty practice. The studies which met our criteria to clear the objective of one phase and two phase treatment were taken into consideration for reference.

Timing of Treatment

American Orthodontist Association recommends an orthodontic consultation for all kids by the age of 7 years. A goal of "early" orthodontic treatment is to correct existing or developing skeletal, dentoalveolar, and muscular imbalances to improve the orofacial environment before the permanent teeth eruption is complete.³¹⁻³³ The "epitome of dynamic orthodontic approach" is the beginning of the treatment in the deciduous dentition.³⁴ Lyman Wagers gave the term "pre orthodontic guidance" and "correction" in substitute for "prevention and interception" respectively.³⁵ Pre-orthodontic guidance-patients are having malocclusions in the deciduous or mixed dentition period, but do not require banding for corrective treatment.³⁶

The ideal time to start a Phase 1 treatment would be in the early mixed dentition, as soon as the upper lateral incisors are erupted. Early treatment is usually not considered in the primary dentition except for few cases of cross bite, Class II and III malocclusion with crowding. Most of these primary dentition problems could be postponed, rather than be faced, with three phases of treatment 1st stage - primary dentition, 2nd stage - mixed dentition, and 3rd stage - permanent dentition.

A retrospective study of Class II mixed-dentition treatment

Heesoo Oh^a; Sheldon Baumrind^b; Edward L. Korn^c; Steven Dugoni^d; Roger Boero^e; Maryse Aubert^f; Robert Boyd^g

ABSTRACT

Objective: To consider the effectiveness of early treatment using one mixed-dentition approach to the correction of moderate and severe Class II malocclusions.

Materials and Methods: Three groups of Class II subjects were included in this retrospective study: an early treatment (EarlyTx) group that first presented at age 7 to 9.5 years (n = 54), a late treatment (LateTx) group whose first orthodontic visit occurred between ages 12 and 15 (n = 58), and an untreated Class II (UnTx) group to assess the pretreatment comparability of the two treated groups (n = 51). Thirteen conventional cephalometric measurements were reported for each group and Class II molar severity was measured on the study casts of the EarlyTx and LateTx groups.

Results: Successful Class II correction was observed in approximately three quarters of both the EarlyTx group and the LateTx group at the end of treatment. EarlyTx patients had fewer permanent teeth extracted than did the LateTx patients (5.6% vs 37.9%, $P < .001$) and spent less time in full-bonded appliance therapy in the permanent dentition than did LateTx patients (1.7 ± 0.8 vs 2.6 ± 0.7 years, $P < .001$). When supervision time is included, the EarlyTx group had longer total treatment time and averaged more visits than did the LateTx group (53.1 ± 18.8 vs 33.7 ± 8.3 , $P < .0001$). Fifty-five percent of the LateTx extraction cases involved removal of the maxillary first premolars only and were finished in a Class II molar relationship.

Conclusion: EarlyTx comprehensive mixed-dentition treatment was an effective modality for early correction of Class II malocclusions. (*Angle Orthod.* 2017;87:56–67)

KEY WORDS: Class II malocclusion; Mixed dentition; Early treatment; Retrospective study

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Accepted: May 2016. Submitted: January 2016.

Published Online: July 8, 2016.

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INTRODUCTION

Orthodontic intervention during the mixed dentition has been widely practiced for more than a century.^{1,2} However, over the past two decades, some investigators have questioned its effectiveness in treating Class II malocclusions. Their concerns are based primarily on the interpretation of data acquired in three randomized clinical trials (RCTs).³⁻⁶ In two of these, the investigators reported that skeletal correction of Class II malocclusions during phase 1 treatment was not sustained during subsequent phase 2 treatment.³⁻⁵ They concluded that early Class II correction did not provide any additional benefits and was less efficient than LateTx treatment and that it placed more burdens on the patients and clinicians.³⁻⁵ However, some of the generalizations from these RCTs may not be applicable for clinicians who use more comprehensive phase 1 treatment approaches that employ the use of partial fixed appliances (2 × 4), headgear, and mandibular lingual arches. Though these modalities have been utilized extensively by some clinicians, treatment outcomes have not yet been rigorously studied.

The present study investigates the outcome of one particular comprehensive mixed dentition treatment

Timing orthodontic treatment: early or late?

PS Fleming

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ABSTRACT

The timing of orthodontic interventions has been a contentious topic for many years with early treatment to address or indeed to prevent skeletal discrepancies in all three spatial planes and to alleviate crowding in common practice. In terms of effectiveness, however, broadly speaking early intervention has not been shown to be superior to later intervention. As such, in view of the additional burden and duration of early intervention, the weight of evidence points to reserving early treatment for localized problems and specific situations with definitive treatment typically initiated in the late mixed or early permanent dentition.

Keywords: Crowding, Interceptive Orthodontic, Early treatment.

INTRODUCTION

The appropriate timing of orthodontic intervention has sparked considerable debate with a body of specialist and non-specialist providers wedded to the routine provision of ‘early’ treatment.¹ However, definitive orthodontic treatment is most commonly started in the late mixed or early permanent dentition. This phase typically coincides with a period of maximal growth, allowing efficient correction of growth-related occlusal anomalies; may permit beneficial use of the leeway space; and offers the availability of permanent teeth for retention of appliances and definitive correction of a malocclusion.

Interceptive orthodontics constitutes any measure performed to correct a developing malocclusion or to simplify later orthodontic care. It has been suggested that developing problems in the mixed dentition could be fully corrected with simple interceptive treatment in 15% and improved in 49% of cases.² Therefore, targeted implementation of simple interceptive measures is important and cost-effective with the general practitioner perfectly placed to identify and occasionally correct developing occlusal problems in a timely manner. However, blanket prescription of early treatment either to prevent or treat a malocclusion at a young age does not appear to be indicated.³ The value of early intervention to intercept localised problems has variously been reviewed;^{4, 5} the present review will therefore focus on the relative merits of early treatment in the management of generalised malocclusion and growth-related issues.

Early Treatment: Theoretical Basis

A range of potential indications for early orthodontic intervention commencing prior to the late mixed dentition phase have been proposed and include:

- A dental health benefit: Early intervention to address crowding may improve access for oral hygiene measures. While this may certainly be the case, there is no evidence that crowding in the mixed dentition is incompatible with periodontal health in the long-term.⁶ There is some evidence that early intervention to address increased overjet may translate into a reduced risk of incisor trauma; however (See Class II correction).⁷
- Psychosocial considerations/benefit: There is a proven association between a range of dental anomalies including increased overjet and overbite, anterior spacing and open bites with teasing and bullying.⁸ Persistent teasing is known to affect self-perceptions and so a malocclusion may have a negative socio-psychological impact. Given that targeting arises on an individual and often unpredictable basis, early treatment to address occlusal issues in those affected rather than as a blanket measure has been recommended on the basis of high-quality prospective research.⁹
- Growth response: The plasticity of the skeleton both in the short- and medium- term has been the subject of lengthy, often vociferous debate. Early research involving cephalometry alluded to the ‘immutability’ of the facial skeleton contrary to what had previously been propounded by orthodontic pioneers.¹⁰ Contemporary research,

Early orthodontic treatment for Class III malocclusion: A systematic review and meta-analysis

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Manchester, United Kingdom

Introduction: Class III malocclusion affects between 5% and 15% of our population. The 2 most common dilemmas surrounding Class III treatment are the timing of treatment and the type of appliance. A number of appliances have been used to correct a Class III skeletal discrepancy, but there is little evidence available on their effectiveness in the long term. Similarly, early treatment of Class III malocclusion has been practiced with increasing interest. However, there has been no solid evidence on the benefits in the long term. The aim of this systematic review was to evaluate the effectiveness of orthodontic/orthopedic methods used in the early treatment of Class III malocclusion in the short and long terms. **Methods:** Several sources were used to identify all relevant studies independently of language. The Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Embase (Ovid), and MEDLINE (Ovid) were searched to June 2016. The selection criteria included randomized controlled trials (RCTs) and prospective controlled clinical trials (CCTs) of children between the ages of 7 and 12 years on early treatment with any type of orthodontic/orthopedic appliance compared with another appliance to correct Class III malocclusion or with an untreated control group. The primary outcome measure was correction of reverse overjet, and the secondary outcomes included skeletal changes, soft tissue changes, quality of life, patient compliance, adverse effect, Peer Assessment Rating score, and treatment time. The search results were screened for inclusion, and the data extracted by 2 independent authors. The data were analyzed using software (version 5.1, Review Manager; The Nordic Cochrane Centre, The Cochrane Collaboration; Copenhagen, Denmark). The mean differences with 95% confidence intervals were expressed for the continuous data. Random effects were carried out with high levels of clinical or statistical heterogeneity and fixed effects when the heterogeneity was low. **Results:** Fifteen studies, 9 RCTs and 6 CCTs, were included in this review. In the RCT group, only 3 of 9 studies were assessed at low risk of bias, and the others were at high or unclear risk of bias. All 6 CCT studies were classified as high risk of bias. Three RCTs involving 141 participants looked at the comparison between protraction facemask and untreated control. The results for reverse overjet (mean difference, 2.5 mm; 95% CI, 1.21-3.79; $P = 0.0001$) and ANB angle (mean difference, 3.90°; 95% CI, 3.54-4.25; $P < 0.0001$) were statistically significant favoring the facemask group. All CCTs demonstrated a statistically significant benefit in favor of the use of each appliance. However, the studies had high risk of bias. **Conclusions:** There is a moderate amount of evidence to show that early treatment with a facemask results in positive improvement for both skeletal and dental effects in the short term. However, there was lack of evidence on long-term benefits. There is some evidence with regard to the chin cup, tandem traction bow appliance, and removable mandibular retractor, but the studies had a high risk of bias. Further high-quality, long-term studies are required to evaluate the early treatment effects for Class III malocclusion patients.

Trial registration number: PROSPERO CRD42015024252. (Am J Orthod Dentofacial Orthop 2017;151:28-52)

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Submitted, February 2016; revised and accepted, July 2016.
0889-5406/\$36.00
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<http://dx.doi.org/10.1016/j.ajodo.2016.07.017>

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Early treatment of Class III malocclusion has been attempted with varying success. The main advantage of early Class III malocclusion treatment is to avoid surgical intervention and thus reduce the morbidity of the surgery. The timing of early treatment is crucial for a successful outcome. Some studies have reported that treatment should be carried out in patients less than 10 years of age to enhance the orthopedic effect.¹⁻⁴ In contrast, other studies have

Retrospective 25-year follow-up of treatment outcomes in Angle Class III patients

Success versus failure

Retrospektives 25-Jahre-Follow-up von Patienten nach Angle-Klasse-III-Behandlung

Erfolg versus Misserfolg

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Published online: 15 February 2017
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Abstract

Objectives Despite recommendations for early treatment of hereditary Angle Class III syndrome, late pubertal growth may cause a relapse requiring surgical intervention. This study was performed to identify predictors of successful Class III treatment.

Materials and methods Thirty-eight Class III patients treated with a chin cup were retrospectively analyzed. Data were collected from the data archive, cephalograms, and casts, including pretreatment (*T0*) and posttreatment (*T1*) data, as well as long-term follow-up data collected approximately 25 years after treatment (*T2*). Each patient was assigned to a success or a failure group. Data were analyzed based on time (*T0*, *T1*, *T2*), deviations from normal (Class I), and prognathism types (true mandibular prognathism, maxillary retrognathism, combined pro- and retrognathism). **Results** Compared to Class I normal values, the data obtained in both groups yielded 11 significant parameters. The success group showed values closer to normal at all times (*T0*, *T1*, *T2*)

and vertical parameters decreased from *T0* to *T2*. The failure group showed higher values for vertical and horizontal mandibular growth, as well as dentally more protrusion of the lower anterior teeth and more negative overjet at all times. In addition, total gonial and upper gonial angle were higher at *T0* and *T1*. A prognostic score—yet to be evaluated in clinical practice—was developed from the results. The failure group showed greater amounts of horizontal development during the years between *T1* and *T2*. Treatment of true mandibular prognathism achieved better outcomes in female patients. Cases of maxillary retrognathism were treated very successfully without gender difference. Failure was clearly more prevalent, again without gender difference, among the patients with combined mandibular prognathism and maxillary retrognathism. Crossbite situations were observed in 44% of cases at *T0*. Even though this finding had been resolved by *T1*, it relapsed in 16% of the cases by *T2*.

Conclusion The failure rate increased in cases of combined mandibular prognathism and maxillary retrognathism. Precisely in these combined Class III situations, it should be useful to apply the diagnostic and prognostic parameters identified in the present study and to provide the patients with specific information about the increased risk of failure.

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Keywords Class III therapy · Prognostic parameters · Treatment success · Chin cup

Zusammenfassung

Einleitung Das Angle Klasse-III-Syndrom ist eine



Case study

Orthodontic treatment of class three malocclusion using clear aligners: A case report

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ARTICLE INFO

Keywords:
Angle class III
Clear aligner
Interceptive orthodontic treatment

ABSTRACT

Class III malocclusion is a growth-related challenging condition for orthodontists. We present a case of a 11-year-old girl with a skeletal class III malocclusion with bilateral cross bite, and a functional shift of the lower dental midline. A multiphase clear aligners' treatment was scheduled with the aim of removing all dental interferences which involved an anterior displacement of the mandible. At one-year follow-up, clear aligners' therapy resulted in skeletal and dental improvements. Clear aligners therapy represents a valid alternative to fixed appliance therapy in the early interception of class III malocclusion. The present manuscript was prepared following the CARE guidelines.

1. Introduction

Class III malocclusion is a challenging dentoalveolar growth deformity, affecting between 5.5% and 19.4% of the population.¹ Early timely treatment of class III malocclusion involves the removal of all occlusal interferences which pathologically determine a forward slide of the mandible.² Clear aligners have been recently employed in the correction of mild to moderate malocclusions in non-growing patients, gaining great success.³ However, there is a lack of evidence regarding the use of clear aligners in the management of growing patients; a case of a young patient with class III malocclusion, treated with clear aligners and supportive myofunctional therapy, is presented.

2. Materials and methods

2.1. Diagnosis and etiology

The patient was a 11.8-years-old Caucasian female with a chief complaint of irregular front teeth (Fig. 1). The general medical history was negative for illness, allergy; the patient did not present any familiarity for class III malocclusion.

Facial photographs revealed a prognathic profile, an obtuse gonial angle, and a lower third asymmetry. Intraoral photographs revealed a transverse skeletal discrepancy, with anterior cross bite affecting upper and lower left lateral incisors. Pseudo-class III malocclusion was excluded, since no discrepancy between centric occlusion and centric

relation was noticed.⁴ At intraoral evaluation, the patient presented a late mixed dentition with a bilateral class III malocclusion, along with a functional mandibular lateral deviation towards the patient's left side, without any sign or symptom of temporomandibular joint disorders. A parafunctional tongue thrust habit and swallowing dysfunction were detected. Panoramic radiography revealed no teeth anomalies. The pre-treatment cephalometric analysis showed a skeletal class III relationship. Referring to the anterior cranial base (Sella-Nasion), the patient presented a retruded maxilla with proclined incisors and a relatively proclined mandible (Table 1). The Sassouni's analysis of vertical facial proportions revealed an open bite tendency, resulting from clockwise rotation of the mandible; this was evident since the palatal plane, occlusal plane, and mandibular plane tended to converge relatively close to the face.

According to the cervical vertebral maturation method, the patient had almost completed her active craniofacial growth (CS4).⁴

2.2. Treatment objectives

The primary objective was to correct class III malocclusion and establish a favorable growth environment.

Additional objectives were to correct the transverse skeletal relationship, to eliminate occlusal interference (dental cross bite) and functional mandibular lateral deviation.

With the aim of establishing physiological tongue posture, an myofunctional therapy was indicated.

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<https://doi.org/10.1016/j.jobcr.2019.09.004>

Received 2 May 2019; Received in revised form 26 August 2019; Accepted 30 September 2019

Available online 07 October 2019

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Indication of clear aligners in the early treatment of anterior crossbite: a case series

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DOI: <https://doi.org/10.1590/2177-6709.25.4.033-043.oar>

Introduction: Anterior crossbite (AC) is defined as a reverse sagittal relationship between maxillary and mandibular incisors. According to an evidence-based orthodontic triage, the treatment need of AC is indicated if any occlusal interference is forcing the mandible towards a Class III growth pattern. Removable and fixed appliances have been suggested to correct AC. **Objective:** The present report aims at presenting the benefits of an alternative therapy for the early treatment of anterior crossbite using clear aligners. **Methods:** Two cases of anterior crossbite corrected using clear aligners in 8-years-old children are presented. **Results:** In both cases, AC was successfully corrected within 5 months. At the end of the treatment, overjet and overbite were corrected. No major discomfort or speech impairment was noticed by the parents. **Conclusions:** Due to the perceived shortcomings of alternative approaches, the use of clear aligners for correcting AC in mixed dentition should be considered as a comfortable and well tolerated appliance for young patients.

Keywords: Orthodontics, interceptive. Malocclusion. Orthodontic appliances, removable.

Introdução: A mordida cruzada anterior (MCA) é definida como uma relação sagital reversa entre os incisivos superiores e inferiores. De acordo com a evidência científica, o tratamento da MCA é indicado em casos em que a interferência oclusal favorece o crescimento mandibular em direção a um padrão de Classe III. A literatura descreve diversos aparelhos removíveis e fixos para a correção dessa má oclusão. **Objetivo:** A presente série de casos tem como objetivo apresentar os benefícios de uma terapia alternativa para o tratamento precoce da MCA por meio do uso de alinhadores transparentes. **Métodos:** Apresentação de dois casos de MCA tratados com alinhadores transparentes em crianças de 8 anos de idade. **Resultados:** Em ambos os casos, a MCA foi corrigida com sucesso em um período de 5 meses. Ao fim do tratamento, obteve-se sobressaliência e sobremordida ideais. Segundo o relato dos pais, nenhum grande desconforto ou comprometimento na fala foi observado. **Conclusões:** Tendo em vista os problemas associados a algumas abordagens alternativas, o uso de alinhadores transparentes para correção da MCA durante a dentição mista pode ser considerado confortável e bem tolerado por pacientes jovens.

Palavras-chave: Ortodontia, interceptativa. Má oclusão. Aparelho ortodôntico, removível.

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Submitted: November 14, 2018 - Revised and accepted: August 11, 2019

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

How to cite: Staderini E, Patini R, Meuli S, Camodeca A, Guglielmi F, Gallenzi P. Indication of clear aligners in the early treatment of anterior crossbite: a case series. *Dental Press J Orthod.* 2020 July-Aug;25(4):33-43. DOI: <https://doi.org/10.1590/2177-6709.25.4.033-043.oar>

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

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RESEARCH

Open Access

Early treatment of posterior crossbite - a randomised clinical trial

Carsten Lippold^{1*}, Thomas Stamm^{1†}, Ulrich Meyer^{2†}, András Végh^{3†}, Tatjana Moiseenko^{1†} and Gholamreza Danesh^{4†}

Abstract

Background: The aim of this randomised clinical trial was to assess the effect of early orthodontic treatment in contrast to normal growth effects for functional unilateral posterior crossbite in the late deciduous and early mixed dentition by means of three-dimensional digital model analysis.

Methods: This randomised clinical trial was assessed to analyse the orthodontic treatment effects for patients with functional unilateral posterior crossbite in the late deciduous and early mixed dentition using a two-step procedure: initial maxillary expansion followed by a U-bow activator therapy. In the treatment group 31 patients and in the control group 35 patients with a mean age of 7.3 years (SD 2.1) were monitored. The time between the initial assessment (T1) and the follow-up (T2) was one year. The orthodontic analysis was done by a three-dimensional digital model analysis. Using the 'Digimodel' software, the orthodontic measurements in the maxilla and mandible and for the midline deviation, the overjet and overbite were recorded.

Results: Significant differences between the control and the therapy group at T2 were detected for the anterior, median and posterior transversal dimensions of the maxilla, the palatal depth, the palatal base arch length, the maxillary arch length and inclination, the midline deviation, the overjet and the overbite.

Conclusions: Orthodontic treatment of a functional unilateral posterior crossbite with a bonded maxillary expansion device followed by U-bow activator therapy in the late deciduous and early mixed dentition is an effective therapeutic method, as evidenced by the results of this RCT. It leads to three-dimensional therapeutically induced maxillary growth effects. Dental occlusion is significantly improved, and the prognosis for normal craniofacial growth is enhanced.

Trial registration: Registration trial DRKS00003497 on DRKS

Background

In children presenting with a functional unilateral posterior crossbite, the maxillary complex is often constricted [1-3]. This abnormal morphological situation is aetiologically based on a multicausal genetic system [4] and influenced in craniofacial growth by different aetiological factors, such as impaired nasal breathing and muscular dysfunction [5-7], as well as prolonged sucking habits after the second year of life [8,9]. Epidemiological studies vary due to the examined collectives and study criteria, though they reveal a prevalence of between 4% and 16% [10-15]. A functional chain is

induced by the maxillary transversal underdevelopment beginning in the deciduous dentition. The interrelation of maxillary and mandibular teeth varies in children between the centric and the maximum intercuspid position. In the centric relation of the condyles with midline concordance, the lower teeth do not occlude in a maximum cuspid-fossa relationship. This unstable maxillomandibular buccal-cuspid occlusion leads to a functional shift of the mandible in maximum occlusion, consequently resulting in a functional unilateral posterior crossbite with midline deviation [6,12,16,17]. In subsequent craniofacial development, a functional unilateral posterior crossbite leads to increased growth on the non-crossbite side and to impairment in the crossbite side [18]. Progreident adaptation of the soft and hard tissues manifests in a unilateral crossbite and possibly

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Phase 1 orthodontic treatment with Invisalign First clear aligners

Constricted arches with an anterior and posterior crossbite in a patient with special needs



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Patient:

Age: 9 year-old male with Asperger syndrome

Chief concern: The main concern was the patient's incisor crowding and anterior crossbite.

Diagnosis:

- Early mixed dentition
- Convex facial profile
- Mild Class III dental relationship on the right side, and end-on Class II molar on the left side
- Anterior dental crossbite, moderate upper arch constriction, and a posterior crossbite on the left side
- Moderate upper anterior crowding; very mild lower anterior crowding
- Minimal overbite
- Moderate gingival recession of the lower left central incisor

Initial records:



Experiences, results and opinions in this article are those of the doctor in his orthodontic practice and not necessarily of Align Technology, Inc. The doctor was paid an honorarium by Align Technology, Inc. for his time to develop this article.

REVIEW

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Systematic review for orthodontic and orthopedic treatments for anterior open bite in the mixed dentition

Lucia Pisani^{1*} , Laura Bonaccorso², Rosamaria Fastuca¹, Raffaele Spena², Luca Lombardo² and Alberto Caprioglio¹

Abstract

Background: The treatment options for the early treatment of anterior open bite are still controversial. The aim of this study was to evaluate the actual available evidence on treatments of anterior open bite in the mixed dentition in order to assess the effectiveness of the early treatment in reducing open bite, the most efficacious treatment strategy and the stability of the results.

Materials and methods: A literature survey was done on November 15, 2015, by means of appropriate Medical Subject Headings (MeSH) using the following databases: PubMed, EMBASE, Cochrane Library, LILACS, VHL, and WEB OF SCIENCE.

Randomized clinical trials and studies with a control group (treated or untreated) were then selected by two authors. Trials including patients with syndromes or in the permanent dentition and studies concerning treatment with extractions, full-fixed appliances, or surgery were not considered.

Full articles were retrieved for abstracts or titles that met the initial inclusion criteria or lacked sufficient detail for immediate exclusion.

Results: Two thousand five hundred sixty-nine studies about open bite were available; the search strategy selected 240 of them.

Twenty-four articles have been judged suitably for the final review, and their relevant data were analyzed.

Discussion: Although this review confirms the effectiveness of early treatment of open bite, particularly when no-compliance strategies are employed, meta-analysis was unfeasible due to lack of standardization, important methodological limitations, and shortcomings of the studies.

Conclusions: A more robust approach to trial design in terms of methodology and error analysis is needed. Besides, more studies with longer periods of follow-up are required.

Keywords: Early treatment, Open bite, Systematic review, Quality analysis

Review

Background

Anterior open bite is a malocclusion characterized by a deficiency in the normal vertical overlap between antagonist incisal edges when the posterior teeth are in occlusion [1].

Dental and dentoalveolar open bite is the result of a mechanical blockage of the vertical development of the incisors and the alveolar component while skeletal relationships are normal; skeletal open bite is determined by a vertical skeletal discrepancy [2]. However, in most cases, the distinction is not clear since malocclusion presents both dental and skeletal components [3].

Skeletal open bite is characterized by increased lower anterior facial height and gonial angle, short mandibular ramus, and increased posterior dentoalveolar height. Concomitant transverse discrepancies may also be present [4]. Additional features are lip incompetence, profile convexity,

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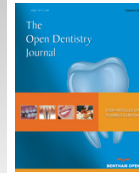




The Open Dentistry Journal

Content list available at: www.benthamopen.com/TODENTJ/

DOI: 10.2174/1874210601711010581



CASE REPORT

Orthodontic Treatment Timing and Modalities in Anterior Open Bite: Case Series Study

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Received: June 21, 2017

Revised: August 16, 2017

Accepted: October 18, 2017

Abstract:

Objective:

The purpose of this study was to present early and adult cases of anterior open bite that were treated efficiently using different treatment approaches and mechanics.

Materials and Methods:

Five patients of different age groups (from 7 to 27 years), suffering from a clear Anterior open bite deformity, were properly diagnosed and relevant treatment modality for each was selected.

Results:

Positive overbite was efficiently achieved for all patients.

Conclusion:

Patient compliance is a key factor in using removable habit breakers. However, fixed palatal crib gave the same results but in shorter time. Anterior open bite of skeletal components should be thoroughly evaluated before selecting camouflage or orthognathic surgery treatment modality.

Keywords: Anterior open bite, Early treatment, Adult treatment, Surgical correction, Habit breaker, Fixed palatal crib.

1. INTRODUCTION

Early orthodontic treatment is becoming more generally accepted as a means of gaining the greatest possible control over mal-growing dentofacial components including anterior open bite. However, in most cases, a second phase of treatment may be necessary to detail the occlusion and maintain life-long occlusal stability; while in others camouflage or even orthognathic surgery is recommended if standard outcome of facial esthetics and oral function are to be achieved.

Speidel *et al.* [1] in a review of the etiology, diagnosis and treatment of anterior open bite, stated that due to the complexity of etiologic factors of anterior open bite, each individual case requires careful and thorough examination to formulate a proper diagnosis and treatment plan for that patient. In a recent study on Italian preschool children, Silvestrini-Biavati *et al.* [2] pointed out the fact that non-nutritive sucking habits are essential etiologic factor of developing anterior open bite in deciduous dentition in addition to type of feeding.

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Paediatric Orthodontics Part 1: Anterior open bite in the mixed dentition

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DOI: 10.23804/ejpd.2019.20.01.15

Abstract

The correction of anterior open bite in the mixed dentition: treatment or over-treatment?

Early treatment of the anterior open bite is a common, widespread treatment, which involves sometimes multiple clinical procedures: active orthodontic treatment and correction of the dysfunctional habits with a large waste of financial and biological costs. Therefore, also considering the significant possibility of self-improvement in the pre-pubertal phase, active early treatment should not aim to the active correction of the AOB, but only to other aspects of the malocclusion and to the interception of dysfunctional habits.

KEYWORDS Anterior open bite; Dysfunctional habits; Orthodontic treatment.

Introduction

Anterior open bite (AOB), or lack of contact of incisors, is one of the most challenging malocclusion to treat. The cause of an anterior open bite is generally multifactorial due to a combination of skeletal, dental and soft tissue issues.

Anterior open bite (AOB) is widespread among young children, with prevalence ranging from 17% to 18% of children in the mixed dentition [Kasparaviciene et al., 2014; Tausche et al., 2004; Silvestrini-Biavati, 2016]. When associated with sucking habits, the prevalence increases to 36.3% [Cozza et al., 2005]. A tendency towards self-improvement from the deciduous to the late mixed dentition is expected during pre-pubertal growth [Worms et al., 1971; Phelan et al., 2014], and it is demonstrated that, if AOB persists during the cranio-facial pubertal growth spurt, it hardly ever self-corrects or even worsens [Phelan et al., 2014]. Thus, in the one hand, it seems indicated to treat the AOB early and to intercept the dysfunctional habits that, if removed early enough, become likely to promote optimal development of the masticatory system. On the other hand, if there is a chance that the anterior open bite will self-correct during growth, all or many of the treatments proposed during the deciduous and mixed dentition should be considered as over-treatment.

Literature review

After more than 50 years of investigations, the extensive literature concerning the early treatment of AOB still is controversial and covers a wide variety of therapeutic approaches [Fränkel and Fränkel, 1983; Kiliaridis et al., 1990; Ngan et al., 1992; Erbay et al., 1995; Sankey et al., 2000; Almeida, 2005; Pedrin et al., 2006; Defraia et al., 2007; Giuca et al., 2008; Quinzi et al., 2018; Giuntini et al., 2008; Doshi and Bhad, 2011; Cerruto et al., 2018]. Retrospective controlled trials (CT) and CCT studies suggested that the combination of different treatment modalities is effective, such as the use of a functional appliance, the bite block, cribs and the high pull headgear in younger subjects.

The above treatments seem effective for the correction of dentoalveolar and skeletal open bite. However these results must be viewed with caution, because the studies showed important methodological limitations and did not reach a quality level sufficient enough to draw any

Phase 1 orthodontic treatment with Invisalign clear aligners

Interceptive treatment of an anterior open bite from a tongue interposition habit



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Patient:

Age: 10.5 year-old female

Chief concern: The main concern of her parents was her “protrusive front teeth.” They wanted her front teeth retracted and her upper lip profile reduced. Both the patient and her parents were apprehensive about receiving fixed metal braces because of a fear of discomfort or pain, and the unesthetic appearance of metal braces.

Diagnosis:

- Early mixed dentition;
- Protrusive upper facial profile with a retrognathic mandible;
- Anterior open bite with severe overjet and severe upper incisor proclination due to a tongue interposition habit;
- End-on Class II molar relationship with mesial-in rotation of the upper first molars;
- Class II skeletal relationship with a prognathic maxilla: SNA = 88° (norm = 82° ± 3°); SNB = 81° (norm = 79° ± 3°); ANB = 7° (norm = 3° ± 2°); severely proclined upper incisors: U1-SN = 127° (norm = 103° ± 6°); lower incisor inclination within normal limits: IMPA = 90° (norm = 90° ± 5°);
- Mild upper anterior spacing and mild lower anterior crowding;
- Constricted V-shaped upper arch.

Initial records:



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