Summaries of Publications

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The use of the Invisalign system in the management of orthodontic treatment before and after Class III surgical approach

Pagani R, Signorino F, Poli PP, Manzini P, Panisi I.
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Aim

To describe the management of a Class III in a 23-year-old male patient treated initially, as well as again at the end, with the Invisalign system and, additionally, with traditional surgery between these two phases. Aside from the Class III, the patient had a deviation of the mandible to the left side and a partial anterior crossbite. The post-treatment records 6 years later provide proof of the stability of the dental and skeletal corrections. The result achieved documents that the Invisalign system can be effective during the orthodontic phases in patients who also require orthognathic surgery.

Materials and methods

A 23-year-old male patient presented with a Class III, complicated by a left lateral deviation of the mandible and a partial crossbite in the anterior region. Further on, painful Temporomandibular Disorder (TMD) with anatomical manifestation in both joints was diagnosed, particularly on the left side. Also on this side, the curves of Spee and Wilson were more distinct. The patient's skeletal and dental asymmetry was even reflected in his facial appearance.

The cephalometric analysis evidenced a brachyfacial configuration with a negative convexity and a slight Class III tendency. The sagittal position of the maxilla was normal. Therefore, the main objective of the surgical approach was to correct the asymmetry that had developed during growth.

Treatment

The entire therapy with the surgical correction included was planned and based on ClinCheck. The system suggested 19 maxillary and nine mandibular aligners. The patient was instructed to wear his appliances for 22 h per day and to change them every 15 days. After 10 months, the pre-surgical phase was concluded and impressions were taken. To plan the surgical procedure, the respective study casts were mounted into an articulator. It turned out that the best operation was a bilateral sagittal split osteotomy with an

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asymmetrical setback of the mandible. On the day before surgery, brackets were applied to all of the patient's teeth. After the surgical intervention, the mandibular segments were stabilised with titanium plates.

After 1 month, all brackets were removed and the post-surgical orthodontic aligner phase initiated. It required five aligners in both arches. Thus, the entire treatment could be completed in 12 months, with a remarkable improvement of both the dental and facial asymmetry. This could be documented by extraoral inspection and by the cephalometric analysis.

A follow-up visit after 6 years showed that the correction was stable. Over this time the TMD had also improved so that the patient was pain free.

Discussion

During growth, the patient's asymmetry manifested itself severely in the mandibular anatomy. According to Planas, this unphysiological growth pattern is due to a left-side chewing pattern, which causes a forward skull base flexion that increases the transverse and the sagittal dimension. Thus, it led to a mandibular prognathism. Deshayes, however, pointed out that a normal skull base flexion is essential for growing individuals to develop a physiological chewing function.

To re-establish the symmetry of the jaws, a non-surgical therapy might be considered, which is self-evidently less invasive, but not always sufficient to solve the problem of a severely morphologic skeletal asymmetry. For this reason, orthognathic surgery was regarded as essential in this patient's treatment.

Other authors have also described the treatment of Class IIIs, but seldom in combination with aligner therapy. A big advantage of this approach is the superior periodontal health and satisfaction of the respective patient.

Conclusion

This patient report is an example of how aligners, instead of fixed appliances, can advantageously be employed before and after orthognathic surgery in Class III patients. With the Invisalign system, the final result can be pre-visualised, which helps with a patient's motivation and satisfaction at the end of the process. The approval is further enhanced by the finer aesthetics and the much easier maintenance of oral hygiene, combined with a comfortable management of this removable appliance. Overall, not only the aesthetics improved in this patient, but also his occlusal and orofacial functions.

Commentary

In this reviewer's opinion, the importance of this paper is to think outside the box. Eve patients with severe occlusal problems could be treated by aligning the arches with the Invisalign system (or another aligner-based method), if surgical intervention is a viable option. Although the patient presented here did not have a complex malocclusion, it was nicely corrected with the described approach. One has to remember that "invisible" treatment might be the main reason to accept orthodontics, even at a more advanced age. Another aspect is that oral health maintenance is not compromised, since all patients can keep their teeth clean as if they had no appliances[1,2].

References

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Management of overbite with the Invisalign appliance

Khosravi R, Cohanim B, Hujoel P, Daher S, Neal M, Liu W, Huanga G
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Aim

The literature about the treatment of overbite changes with the Invisalign system consists mainly of a single or a series of patient reports. In this retrospective study, the cephalograms of 120 successive patients were analysed to assess how Invisalign aligners influenced the overbite. The background of this interest was the common opinion that aligners cover the posterior teeth and thus, have some kind of bite block function, which would ultimately lead to a deepening of the anterior overbite. Align Technology tried to solve this previously assumed immanent problem, for example by the introduction of virtual bite ramps, which unload the posterior teeth of the dentition and allow their normal vertical development.

Materials and methods

This was a retrospective study of 120 consecutive adult (> 18 years) patients who were treated by three different experienced practitioners exclusively with the Invisalign system. Exclusion criteria were the necessity of major transverse or anteroposterior changes and the need for extractions (and surgery).

The median age of all patients was 33 years, and 70% of these were women. In total, 68 individuals had a normal anterior overbite, 40 a deep bite and 12 an open bite. The stratification of the sample was based on a measurement of the vertical incisor relationship on good quality cephalograms that were blinded for the investigators. Overbite was measured as the shortest vertical distance between the tip of the maxillary and the mandibular incisor, perpendicular to the occlusal plane. Normal overbite was defined as edge-to-edge bite up to less than 4.0 mm overlap. Every coverage of 4.0 mm, or greater than 4.0 mm, was labelled as deep bite. Respectively, open bite was defined as less than edge-to-edge bite. The patients received up to 40 aligners (per arch) and eventually three revisions.

The pre- and post-treatment cephalograms were analysed with the Dolphin Imaging System, using 17 landmarks. The software then calculated nine linear and three angular measurements. Reference lines were the palatal, the occlusal and the mandibular plane. For all individually assessed distances and angles the reader may consult the original article.

About 2 weeks after the first examination, 10 randomly selected cephalograms were retraced, marked and reanalysed for a measurement error analysis (= difference between the first and second assessment).

All data were subjected to standard statistical procedures, with the level of significance set at ≤ 0.05.

Results

The intra-examiner error amounted to 0.03 ± 0.08 mm for the parameter overbite. For all linear measurements this error was smaller than 1.0 mm, for the angular evaluation less than 1 degree, indicating a very good data reproducibility.

On average, the overbite in patients with an initial normal vertical anterior relationship was reduced by 0.3 mm (due to a slight extrusion of the posterior teeth), which basically indicates that it was not changed. At the same time, a minor proclination of the maxillary (significant) and mandibular (non-significant) incisors could be observed.

In patients with a deep bite at the start of treatment, the bite was raised 1.5 mm (median) primarily by a proclination of the lower and an intrusion of the upper incisors. At the same time, the mandibular molars were extruded, although the amount was within the range of the measuring error.

Conversely, patients who demonstrated an open bite before treatment experienced a median reduction of 1.5 mm, which was primarily caused by an extrusion of the incisors in both maxillae. No significant linear changes in the posterior area of this group were observed.

Finally, the outcome of a questionnaire filled in by the three operators showed similar strategies to cope with overbite. In patients with normal anterior overbite the aligner part distal to the first molar was commonly cut off and the Curve of Spee maintained. In deep bite situations,

over-corrections and virtual bite ramps were used and levelling of the Spee curve was attempted. The open bite problem was universally approached with attachments for incisor extrusion.

Discussion

According to these authors, the understanding of the Invisalign system is mostly still limited to marketing claims from Align Technology and (a series of) patient reports, whereas unbiased studies on large samples analysed with rigorous research methods are largely missing. This was the main reason for this investigation, which attempted to elucidate the mechanisms behind changes of the vertical overbite in patients with very different original conditions.

One main aspect is that the early observation of a potential bite deepening caused by intrusion of the posterior teeth cannot longer be perpetuated. If a normal overbite is basically maintained, this can most likely be attributed to the use of bite ramps in aligners which lead concurrently to a minor (primarily) molar extrusion.

This study is the first to also look at a large sample of deep bite patients. Commonly, even if improvement was registered, there were severe deep bites that were not converted into regular overbites. This could be attributed to the fact that these patients were treated with the Invisalign system before the introduction of the G5 technology, which aimed particularly at the treatment of this patient group.

The open bite individuals experienced a reduction of this symptom by extrusion of their incisors. However, in consistency with other publications, aligners are also not in a position to correct severe open bites. The patients in this experiment had only mild to moderate open bites and not all had a positive overlap at the end of their therapy.

One problem with this study was that the patient records did not contain all the various strategies used to maintain or change a person's overbite. Because of this, the authors added an extensive table, which lists all the little knacks and tricks used by these experienced Invisalign providers. Its content is outside of the scope of this review, which is why studying this compilation is highly recommended.

Overall, the authors came to the conclusion that the effectiveness of Invisalign aligners to correct deep and open bites compared with fixed appliances is, on average, somewhere around 50%.

Self-critically, the authors remark that their method – cephalograms – had its inherent problems: head positioning, movement during exposure, inconsistent exposures, magnification errors and inconsistencies with landmark identification. On the other hand, they did their best to keep all these errors to a minimum. Also, one has to acknowledge that when it comes to a comparison of the three overbite groups, this is a systematic failure that affects all three samples to the same degree.

Another limitation of this study is that the open bite group was comparatively small (only 12 individuals).

Conclusion

Invisalign aligners are effective to maintain normal overbites, to decrease deep (mainly by proclination of the mandibular incisors) and open bites (mostly by incisor extrusion). An intrusion of the posterior teeth does not have to occur if good treatment strategies are applied.

Commentary

The main merits of this article are:

1. That is does away with the very dominant idea that the Invisalign system frequently tended to lead to posterior open bites.
2. That it states that deep bites are not easy to correct (only before the introduction of G5?), particularly if they are of severe trait. The correction is at least partially a consequence of a questionable protrusion of the mandibular incisors. However, even with fixed appliances it is not easy to correct this malocclusion, especially when the smile line/facial configuration is taken into consideration.
3. That it points out that severe open bites are difficult to convert into regular overbites, which is again also a challenge with fixed braces.
4. That it shows in one table the approach the individual practitioners took to handle the specific problem. Even if it reflects different strategies for the same malocclusion it could give the reader a stimulus to incorporate other features into one's standard operational procedures.

Orthodontic treatment modalities: a qualitative assessment of internet information

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Aim

This study tried to find out how qualified, accurate, reliable and useful internet information is when it comes to various orthodontic treatment systems.

Method

One of the authors started the internet search with Google plus AdWords and the idiom "orthodontic treatment". Subsequently, the system defined 20 key words, with cosmetic braces, fixed braces, removable braces, Quick braces and risks of orthodontic therapy the five most frequent public search terms in May 2013. These were submitted to five different search engines – Google, Yahoo, AOL, Ask and Bing. This resulted in the display of 2,000 websites in total. After the most recurrent terms above were entered, 544 websites remained.

The centre point of this investigation was the analysis of the first two search engine result pages (SERP). When the authors applied various exclusion criteria, for instance websites consisting basically of promotion, advertisement, videos, discussions or scientific articles, the number of relevant, English websites fell to 119.

The quality of the chosen websites was analysed with five specific evaluation tools for internet sites with medical content: Discern, LIDA (lifetime data), JAMA (Journal of American Medical Association) benchmarks, HONseal (Health on the Net) and FRES (Flesch Reading Ease Score). Furthermore, data such as author, type of site, ranking on SERP, country, search engine, keywords and kind of orthodontic treatment promoted, were registered.

The following five sections give detailed descriptions of the origin, the goal and rating system of these five assessment tools. For particulars, the reader is referred directly to the text.

To validate the results, the intra-examiner reliability and consistency, 15 websites were re-analysed at random at 2-week intervals with Cronbach's Alpha and the Cohen Kappa test. All data were subjected to descriptive and inferential statistics. Binomial and ordinal logistic regression analysis and ANOVA were applied to find out whether there is a relationship between the website characteristics and the quality assessment tool scores, and between the various tools themselves. Routinely the level of significance was set at 0.05.

Results

The intra-examiner consistency and reliability was good for the LIDA and FRES scores (Cronbach value 0.8, respectively 0.9). The Kappa value varied between 0.9 (for LIDA) and 0.6 (for Discern).

Most of the 119 websites fitting this analysis were designed by orthodontists and general practitioners. However, laypeople, universities, official institutions and companies also contributed to the diversity of sites. Just over half (55%) of the included websites contained the keywords "cosmetic" and "fixed appliances". In all, 13 treatment modalities were promoted on these websites, with Invisalign (80%) the one being offered most, followed by classic fixed and removable appliances. The content was best on specialist websites, whereas general clinicians offered more compromising options on lower-quality websites. Their short-term solutions included Six Month Smile, Inman, Insignia, Social 6 and similar aligner systems.

The optimal assessment was produced with the LIDA programme with a mean of 62.0 ± 7.5 followed by FRES (56.2 ± 13.8) and Discern (51.7 ± 14.9).

In general, no dependable relationships were found between variables such as keywords, content and ranking order on one side and quality scores on the other. However, the regression analysis revealed a significant relationship between the type of author and a Q and A section, with high scores for the Discern and LIDA programmes. Further, the ANOVA test resulted in one significant relationship between

Discern scores and LIDA; no similar rapport existed between the other assessments tools.

Discussion

From the very detailed discussion, the following aspects seem to be the most essential:

How important websites are can be seen by the fact that purportedly 60% of the US population consult the internet for information about health issues. None of the current websites are subject to any kind of exactness control. Only one website carried the HONseal emblem, which signals it can be considered reliable, easy to understand and having trustworthy facts, even though this does not automatically mean it is based on solid scientific evidence.

"Aesthetic solutions" towered above those with fast treatment as the key feature offered by specialists and general practitioners alike. More demanding devices such as headgears, miniscrews, self-ligating bracket systems, lingual braces and functional appliances were more or less only described on sites by specialists in orthodontics. When generalists recurrently offer aligner systems this is no surprise, because these require barely any training and clinicians are only marginally involved in treatment planning.

The limitation of this study is that all the websites involved were only scrutinised at a single point of time, despite the worldwide web being such a dynamic, ever-changing media.

Conclusion

The scrutinised websites presented information about orthodontic treatment and were of inconsistent quality. Orthodontic specialists delivered the best information. Invisalign was the most suggested treatment option. It would be in patients' interest if the specific websites provided more valid and reliable advice.

Commentary

It seems to be advantageous if a website:

- Is designed with care because it can become a valuable referral source;
- Could be easily understood by the enquirer;
- Is extended by a Q and A section that allows the interested reader to gain in-depth information;
- Offers more than just "bread and butter" treatments;
- Is regularly updated with "the latest and the best" – if respective evidence exists;
- Provides links to scientific institutions/material;
- Is accredited with an HONseal, which gives it seriousness and allows it to stand out.

Accuracy of printed dental models made with two prototype technologies and different designs of model bases

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Am J Orthod Dentofacial Orthop 2017;151:1178–1187.

Aim

The aim of this study was to evaluate the precision of printed models with three different base configurations deriving from intraoral scans using two different 3D printers.

Method

Rapid prototype printing of orthodontic models was introduced in the 1980s. Since then the technique has multiplied so that a good number of 3D printers are available that can work with various materials. In dentistry, three different prototype printing systems are mainly used: stereolithography, triple jetting and fusion deposition.

Stereolithography is basically a stepwise curing of liquid acrylic by a laser. In triple jetting, the printer deposits layers of liquid photopolymer that are continuously cured. Lastly, in fusion deposition, films of thermoplastic filaments are gradually placed on top of each other. The latter is considered the least accurate and therefore not often used in dentistry or included in this study.

So far, only a few studies have investigated the accuracy of printed vs plaster models with small samples (from just one pair to a maximum 10 pairs). Because of the limited sample sizes it seems problematic to draw valid conclusions for the orthodontic clinic. Also, it is unclear whether the shape of a printed model has an influence on its accuracy. This shape can vary, e.g from one with a regular base to a simple horseshoe shape to a horseshoe form with a connecting bar in the region of the terminal teeth.

An initial sample size calculation revealed that 10 pairs in each group (two printers each with three model configurations) would be sufficient to provide relevant results. Therefore, the dentitions (adult, complete, no anomaly of size and shape, no abrasions/attritions/erosions etc) of 10 random volunteer individuals were scanned with a TRIOS colour intraoral scanner according to the manufacturer's instructions. The files were stored on a computer and subsequently exported into Appliance Designer Software (3Shape) for construction of the three model base shapes.

Following this, the digital models were sent electronically to two dental laboratories with different printing techniques. Initially, 30 models were produced using a light-curing methacrylat resin and a light-processing 3D printer (Ultra 3PS Ortho = SLA) with a 0.10 mm layer thickness. The remaining 30 models were fabricated with a photopolymer resin using a polyjet 3D printer (Objet Eden260VS) with a 0.02 mm layer thickness.

The printed models were scanned in the two laboratories with different scanners – the Ultra 3PS Ortho samples with a Flash computed tomography scanner and the Objet Eden260VS objects with a R700 laser scanner. The models with the standard base acted as reference for all measurements of precision because they were the ones tested in previous studies and because the superimpositions of the intraoral scans with the models from both printers showed only an average difference of 0.01 mm. All superimpositions were made after digitally cutting off the different bases (to avoid any influence of their configuration) according to the automatic best-fit alignment with the Geomagic Qualify software, using colour coding to reveal any (positive and negative) differences bigger than 0.50 mm. Five transverse distances (right to left buccal cusp tip from canine to second molar) were also measured twice with the Ortho Analyzer programme by the same skilled investigator, with a 2-week gap between measurements.

Various statistical methods, including a mixed-effects regression model and the paired *t*-test were applied to analyse the accuracy of the diverse approaches. The level of significance was set at $P > 0.05$.

Results

Statistical analysis with the intraclass correlation coefficient (ICC; being at least 0.984) and Cronbach's alpha did not disclose any systematic measurement error between the

models with different bases. The ICC also did not indicate any large random errors by the respective investigator for the repeated measurements.

For the SLA printed models with the standard base and those with the bar-connected horseshoe base, very similar measurements were obtained. The values were smaller with the simple horseshoe base models. The polyjet printed models all had small transverse differences. However, the mixed-effects regression model demonstrated a slightly better performance using the polyjet printing technique. Generally, the SLA led in the maxillary arch to a variability of 0.21 mm (increasing from the canines to the second molars) whereas it was 0.00 mm in the polyjet printed samples. The respective values for the mandibular arch were 0.06 mm and 0.00 mm.

The mixed-effects regression model with the solid base showed that the models with the horseshoe-shape base were normally 0.70 mm smaller in the transverse dimension, but not those with an additional bar. The polyjet printed ones showed no dependence of the base configuration.

The paired *t*-test assessment of the superimpositions eventually resulted in significant differences in the case of the SLA printer, but not so with the polyjet technique.

Discussion

The "beauty" of intraoral scanning is that a good number of potential errors of impressions can be avoided. The respective data do not really require any physical space for storage and can be transferred with ease at any time. These facts make scanning even more attractive. Independent of this, time and again orthodontists still like to take a "real" model for analytical or educational purposes in their hands. Such models are even indispensable when it comes to manufacturing orthodontic devices. This is when 3D printing comes to the fore. Printed objects are lightweight and comparably very resistant to breakage or abrasion.

As good as current printers are, they often have the disadvantage of high running costs. Also, their handling requires expertise because the materials being used are not only light sensitive, but also toxic. Aside from this, SLA printed objects need a post-curing treatment because the printer can obviously not completely finish the polymerization process. The past processing, however, can compromise the accuracy of the reproduction. For the present study, post-curing of the SLA models was performed with a 400 Watt UV lamp for 20 s. This could have led to some shrinkage, particularly when there was no stabilising base. This shortcoming does not occur with the polyjet printer, but at the cost of higher expenditures. Both systems work with a different thickness of the individual layers (SLA > polyjet) but this had no influence on the precision of the reproduction.

The results of this study are confirmed by those of previous studies, but also extend their perspectives.

Conclusion

The accuracy of SLA and polyjet printed models was evaluated by superimposition and digital measuring. It proved that polyjet reproductions are fully accurate, regardless of the shape of the object base. In the case of the SLA printer application, any base will increase precision, even it is only a transverse bar.

Commentary

Rapid prototype printing will be on the rise – if not skyrocketing – in the near future. Orthodontists should keep their eyes (to read the relevant literature) and ears (to listen to expert colleagues, not just company representatives) wide open so as not to be too late to jump on the bandwagon. This investigation indicates that SLA printing is as reliable as polyjet printing – and time is money. What is clear is that any new technology should be at least as good as the traditional version, but preferably always superior.