The Role of Digital Setup in the Orthodontic Treatment with Plastic Aligners

CAMELIA SZUHANEK*, ADELINA GRIGORE*, ELEONORA SCHILLER, DANA CRISTINA BRATU, DOINA ONISEI, DAN ONISEI
University of Medicine and Pharmacy "Victor Babes" Timisoara, Faculty of Dental Medicine, 2 Eftimie Murgu Sq., Timisoara, România

Orthodontic treatment with the clear plastic aligner is becoming one of the most popular treatment options among adults and teenagers. The high precision of the virtual planning of the case leads to well fitted thermoformed plastic aligners and an individualized treatment for each patient. Several cases were treated with Clear Aligner therapy. All treatment outcomes were previsualized with the digital OrthoAnalyzer CAD software (3Shape) in order to design specific appliances for specific dental movements, with a lower risk of root resorption or other secondary effects. All desired dental movements can be measured and then transposed into a series of amorphous plastic aligners. Patient compliance and communication with the dental laboratory are enhanced due to the continuous developing of the CAD/CAM technology and Clear Aligner system.

Keywords: digital setup, OrthoAnalyzer, plastic aligners

Orthodontic biomechanics with plastic aligners is one of the latest treatment options among adult patients. Clear Aligner therapy became a viable alternative to braces and traditional orthodontic treatment. These thermoformed plastic aligners were used before only as passive retainers to prevent relapse [1]. In the last few years, CAD/CAM technology became an important adjuvant in the orthodontic field. A variety of companies developed several digital software programs to allow orthodontists to plan different dental movements and treatment alternatives by designing a series of vacuum formed or thermoformed aligners [2, 14]. Clear Aligner provides the 3 Shape OrthoAnalyzer software, a vastly used program due to its simplicity and efficiency.

Clear Aligner therapy uses Duran foils (Scheu Dental) for manufacturing the orthodontic appliances. These foils are made from PETg (polyethylene terephthalate and glycol modifiers). This type of amorphous plastic provides biocompatibility and helps patients maintain a proper oral hygiene [1,3].

Several foils are available : CA soft (0.5 mm thickness), CA medium (0.625 mm), CA hard (0.75mm) and CA retention (1mm). Each type must be worn for at least one week before proceeding to the next one. Every three weeks the series of aligners will be changed and the treatment progresses to the next step (a new impression and a new dental cast). These devices must be worn at least 22 h a day. Some minor discomfort may appear in the first 48 h due to increased tension among the periodontal fibers. Because of this, patient compliance is mandatory [4]. Depending on the severity of the malocclusion, multiple series of aligners may be needed. The digital setup provides information about the number of aligners that must be manufactured in order to assure treatment success. An accurate dental impression is necessary in order to obtain the virtual dental situation [2,5]. By scanning the dental impressions or the dental cast the virtual setup can be obtained. The orthodontist may then proceed to the treatment planning phase with the use of the OrthoAnalyzer software.

Another way to proceed to the treatment phase is to use the Gestaligner online program. This application allows orthodontists to upload the intraoral photographs of the patient and the dental X-rays. Dental casts are also sent to the company. After analyzing the received data, the Clear Aligner orthodontists and dental technicians can elaborate the series of aligners. The appliances are then sent to the clinic and the treatment can begin. This type of protocol is less time consuming for the specialist [6].

Case selection is very important. Severe malocclusions, such as skeletal discrepancies cannot be properly managed with this type of appliances but minor tooth movements such as rotations, space closure, crowding, intrusion can be easily corrected. The role of the digital setup is to visualize the treatment possibilities, the required dental movements but also the limitations of the selected case. Dental malocclusions with crowding may also require some IPR (interproximal enamel reduction). The amount of IPR can also be virtually planned and can later be done with the use of some stripping bands and some additional chair time [7, 8]. The company offers a stripping chart as well. By consulting the chart the orthodontist can evaluate the recommended amount of enamel reduction by taking into account tooth anatomy and morphology [6, 14].

Other dental movements may require resin attachments. Flat dental surfaces do not provide enough retention for the plastic aligners. These attachments can be designed with the use of the 3 Shape OrthoAnalyzer software and the Mini-Mold Starter Kit. When attempting to correct the position of a severely rotated tooth or when better torque control is needed, auxiliary attachments are often needed. The resin attachments can be virtually designed. A variety of shapes are commonly used: rectangular, ellipsoidal, round, atypical, etc. The position of these auxiliary components is also important as they can be vertically or horizontally placed. Also, the aligner's retention is increased when resin components are added on the tooth surface[9]. The software program allows the doctor to select the design of the attachments considering the desired result.

** email: cameliaszuhanek@umft.ro; grigoreadelina@yahoo.com*

Our study objective was to emphasize the importance of the communication between the orthodontist and the dental laboratory[10]. By using the R700 3 Shape digital scanner in order to create a virtual model of the patient's dental situation and the OrthoAnalyzer CAD software to plan the treatment mechanics, this communication is improved. The software allows an accurate treatment planning, previsualization of the final result and computer assisted manufacturing of the needed number of aligners. A high precision appliance can be achieved, leading to a successful treatment outcome. The digital software provides a tool box with multiple features such as arch symmetry, amount of interproximal reduction, auxiliary attachments for better control of specific dental movements, use of elastics, etc. The needed number of aligners and the treatment time can also be easily estimated.

Experimental part

In order to evaluate the effectiveness of the digital setup regarding treatment planning , we decided to use the Clear Aligner technology in some clinical cases. The experimental digital setup was performed in S-Rotariu-Kieferorthopädisches-Labor, Switzerland. The patients were satisfied with this alternative because of its esthetic advantage compared with the traditional straight-wire bracket appliance. A clinical case was selected in order to emphasize all the information stated above (fig. 1).

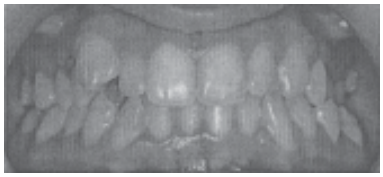

Fig. 1. Adult patient J.A.: Intraoral photography before treatment(frontal view)

This patient was unsatisfied with her smile because of her crowded teeth. All treatment options were presented and Clear Aligner therapy was chosen [13]. Impressions were taken, scanned, and the digital setup was created. This allowed us to design the resin attachments, the series of plastic aligners and previsualize the expected orthodontic results. This also helped us with patient compliance [10] due to the previsualization option with the OrthoAnalyzer CAD software (fig. 2-5)

Fig.2. The digital setup of the case: OrthoAnalyzer software after the 3D scanning procedure

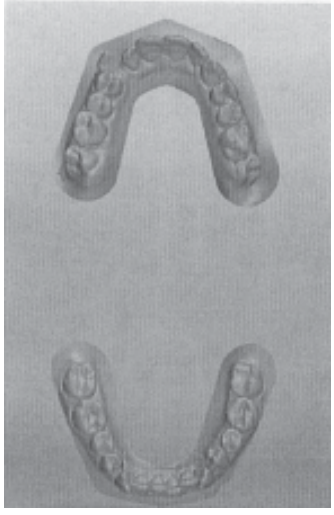

Fig.3. Digital setup: upper and lower arch before treatment

Fig. 4. Digital setup: upper arch

Fig. 5. Digital setup: lower arch

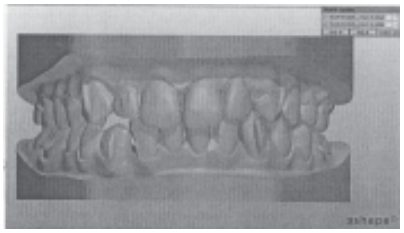

Fig.6. Digital treatment planning: attachments placement

Vertical resin attachments (fig. 6) were added on all canines and molars and on the lateral incisor in order to have better control regarding rotations, tipping and cross bite correction [11].

Results and discussions

OrthoAnalyzer provides measurements of the expected dental movements in order to provide an accurate thermoplastic appliance. Every aligner must induce enough tension on the dental surface without leading to the aligner's wear off [12, 14]. Without any specific requirements the orthodontic treatment would simply be randomly conducted. For our case report several measurements were conducted (table 1).

Table 1

PREDICTED ORTHODONTIC TOOTH MOVEMENT (OTM) WITH THE DIGITAL SOFTWARE: ROTATION, ANGULATION AND INCLINATION IN THE FIRST QUADRANT (DEGREES)

Tooth	Rotation	Angulation	Inclination
1.5	-2.8	-0.8	0
1.4		-0.8	
1.3	-7.8		
1.2	25.8	2.8	5.3
1.1	0	0.5	2.9
2.1	-4.6	-0.1	1.4
2.2	-17.5	0.5	1.3
2.3	35.4	4.7	6.4

Because of these specific values, (measured in degrees) accurate appliances from plastic material were designed for this selected case. The treatment outcome is more precise (fig.7,8) with the use of the digital setup compared with the classic one (that some dental laboratories still use) due to human error elimination.

Fig.8. The expected final result: lower arch

Fig.7. The expected final result: upper arch

Conclusions

Modern appliances and virtual planning of the treatment allows orthodontists and patients to visualize the final orthodontic goal. This is very helpful when it comes to patient compliance and full time wear. The case report presented above emphasizes the accuracy and efficiency of the digitalized treatment mechanics. Starting with an optic impressions, a digital 3 D scanner(R700 3 Shape), a digital printer for the dental arches and a computer aided design of the amorphous plastic aligners (OrthoAnalyzer 3Shape) provides an individualized orthodontic treatment for each case.

Special pliers are also provided from Clear Aligner to customize and activate the appliances. Diagnosis and case selection becomes much easier, reducing significant chair time. These appliances provide a better alternative to braces due to its multiple advantages: esthetics, comfort, less risk of pronunciation problems, root resorption, caries, decalcifications and gingivitis. More studies are required to extend the use of the Clear Aligner system when it comes to more severe malocclusions.

Acknowledgement: The authors would like to thank dr Sebastian Rotariu from S-Rotariu-Kieferorthopädisches-Labor, Switzerland, for his help with digital setups.

References

1. ECHARRI P. Clear aligner: an efficient, esthetic, and comfortable option for an adult patient, World journal of orthodontics 02/2007**;** 8(1):13-8.
2. GRABER L.W., VANARSDALL R.L., VIG K.W.L." Orthodontics : Current Principles and Techniques" ,5th Edition,Elsevier, Philadelphia; July 2011;
3. CARL T.D. Orthodontic Tooth Movement with Clear Aligners, ISRN Dentistry, vol. 2012 (2012), Article ID 657973, p.7
4. BOLLEN A." Activation Time and Material Stiffness of Sequential Removable Orthodontic Appliances", American Journal of Orthodontics and Dentofacial Orthopedics;Volume 124, Issue 5,November 2003, p 496-501
5. LAI H.H.. E.,YAO C.C." Orthodontic treatment with a series of vacuum-formed removable appliances-case report", J Dent Sci**,** 3(3),2008, p 167-173
6. ECHARRI P. Clear Aligner 1st Edition, Ripano S.A., Madrid, 2013, p.34-40, 209;
7. GOMEZ J. Initial force systems during bodily tooth movement with plastic aligners and composite attachments: A three-dimensional finite element analysis, Angle Orthod. 2015 May**;** 85(3):454-60
8. JUSTIN R. Variables affecting orthodontic tooth movement with clear aligners, AAO, April 2014, Vol.145, Issue 5, Supplement, p S82-S91
9. DASY H. Effects of variable attachment shapes and aligner material on aligner retention, Angle Orthod. 2015, Feb. 26, DOI: **10**.2319/091014.1
10. ARLEN J. HURT Improving collaboration and clinical outcomes, Orthodontic Practice US, vol. 2,nr. 4, p. 2
11.SIMON M.,KEILIG L." Forces and Moments Generated by Removable Thermoplastic Aligners: Incisor Torque, Premolar Derotation and Molar Distalization" BMC Oral Health 2014, 14:68
12. GARDNER G., Wear Comparison of Thermoplastic Materials Used for Orthodontic Retainers, American Journal of Orthodontics and Dentofacial Orthopedics;Volume 124, Issue 3, 2003,Pages 294-297
13. JAE HYUN PARK Deep-Bite Correction Using a Clear Aligner and Intramaxillary Elastics, JCO 2009, vol. XLIII, nr. 3,p. 153-154
14. GHIBAN N., BORTUN\ M., BORDEASU I., GHIBAN B., FAUR N., CERNESCU A., Evaluation of mechanical properties by stereo-and scanning electron microscopy of some heat curing dental resins, Mat. Plast, **47**, no. 2, 2010, p.240

Manuscript received: 2.03.2015