A Comparative Study Regarding the Deformation Values of Orthodontic Aligners

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Orthodontic therapy using aligners is a modern treatment option among adult patients. In order to have an optimal control of the orthodontic resuslts, there is a need for knowing the deformation values that can appear in each type of aligner, the optimal thickness values of the appliances and the needed number of aligners for each case. The deformation values for a 0.2 mm repositioned lower central incisor were measured with the use of some strain gauges applied at this level, after a manual set-up was manufactured. Different orthodontic forces were applied on each aligner in order to compare the deformation value during the dental correction. The thickness values of the aligners that were used for this study were 0.625 mm, 0.75 mm and 1 mm. The 0.625 mm aligner had the lowest deformation value dueto a high elasticity of the material.

Keywords: aligners, deformation, strain gauges

The high request for esthetic orthodontic treatment led to a continuous improvement of the invisible techniques such as aligners. The manufacturing materials vary a lot, depending on the orthodontic purposes (alignment or relapse prevention) and the orthodontic system. Based on a manual or a digital set-up, thermoplastic materials are the most common materials that can be used for the manufacturing of orthodontic appliances, that can lead to dental corrections, space closure, derotations or simply maintaining the results after an active orthodontic treatment. Nowadays, the most used appliances are polyurethane and polyethylene aligners, due to the elastic properties of these materials. These characteristics allow a gradual dental movement towards the ideal position of the teeth, enhancing the patient's comfort [1, 2]. The behaviour of different aligners was studied by many authors in order to evaluate the deformation rate of these devices, after a prolongued use within the intraoral environment, therefore proving the efficiency of this type of treatment. Resistance to elongation, intraoral behaviour, material characteristics and thickness values are only a few factors that must be taken into account in any orthodontic treatment plan [3- 5].

Experimental part

Material and methods

A class I Angle malocclusion (with spacing and agressive periodontitis) female patient was selected. The orthodontic treatment objectives consisted of closing of the spaces and reducing the proclination of the lower incisors. A manual set-up was done with minor dental corrections of the lower frontal teeth (a 0.2 mm repositioning). Based on this set-up, 3 vacuumformed polyehylene aligners, with different thickness were manufactured: 0.625 mm, 0.75 mm, 1mm. On each aligner, strain gauges were applied. A vertical 3 mm force was exerted on the lower central incisor axis, after the placement of the aligner on the initial dental cast (without the dental corrections). These strain gauges were connected to a strain bridge that measured the tensile strain and the compression values within the aligner, to a computer (fig. 1-4). The study objective was to determine the efficiency of these aligners regarding the rate of the required dental movements.

Fig. 1. The aligner applied on the initial dental cast

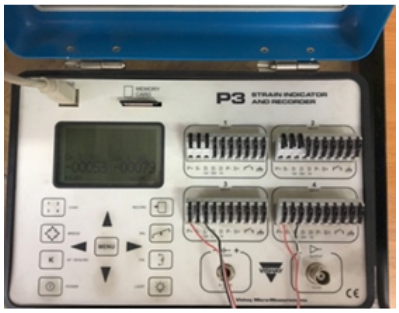

Fig. 2. The strain bridge

Fig. 3. The strain bridge connected to the computer

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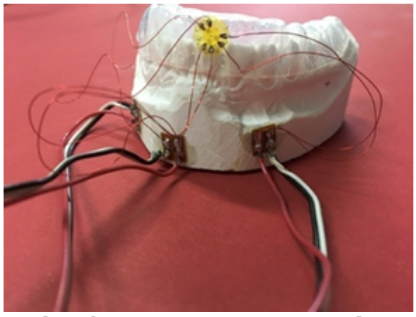

Fig. 4. The strain gauges glued to one of the aligners

The aligners were maintained several hours in order to evaluate the behaviour of these appliances over a longer period of time. The treatment philosophy of the invisible systems consists in a 2 week wear of each aligner [6, 7]. If the deformation rate of these aligners is not too high, the efficiency is quite good and the expected result appears in a shorter period of time.

Table 1

THE EVALUATION OF THE DEFORMATION FOR THE 0.625 mm ALIGNER

Strain gauge: The 0,625 mm aligner	1	2	3
Value	+00008	+00006	+00010
Value	-00042	-00328	+00941
Value	-00084	-00337	+00944
Value	-00090	-00343	+00941
Value	-00085	-00335	+00948

Table 2

DEFORMATION EVALUATION FOR THE 0.75 mm ALIGNER

Strain gauge: The 0,75 mm aligner	1	2
Value	+00276	-00508
Value	+00378	-00531
Value	+01116	-00583
Value	+01432	-00615
Value	+01344	-01164
Value	+01271	-01887

Table 3

DEFORMATION EVALUATION FOR THE 1 mm ALIGNER

Strain gauge: The 1 mm aligner	1	2	3
Value	-00007	00019	00001
Value	-00214	00078	00001
Value	00394	-01784	-00119
Value	00183	-01943	-00380
Value	00191	-01925	-00381
Value	00383	-02072	-00439
Value	00484	-00556	-00116

Results and discussions

Based on our recordings, the tensile strain (possitive values) and the compression values (negative values) were determined for each aligner thickness included in this study: 0.625 mm, 0.75 mm and 1 mm (table 1-3). The values are expressed in micrometers.

Conclusions

Orthodontic aligners require cooperation from the patients in order to be effective. Furthermore, based on the study above, in order to profit from a shorter treatment time, we recommend the 0.625 mm aligner. This thickness had the lowest values regarding the tensile strain and the compression rate, therefore, it facilitates a more efficient correction of the dental malpositions [9-11]. The manufacturing material is polyethylene, an elastic material that provides comfort. The dimensional stability and the water absorption are relatively low [8] when compared to other materials used for the invisible orthodontic systems.

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