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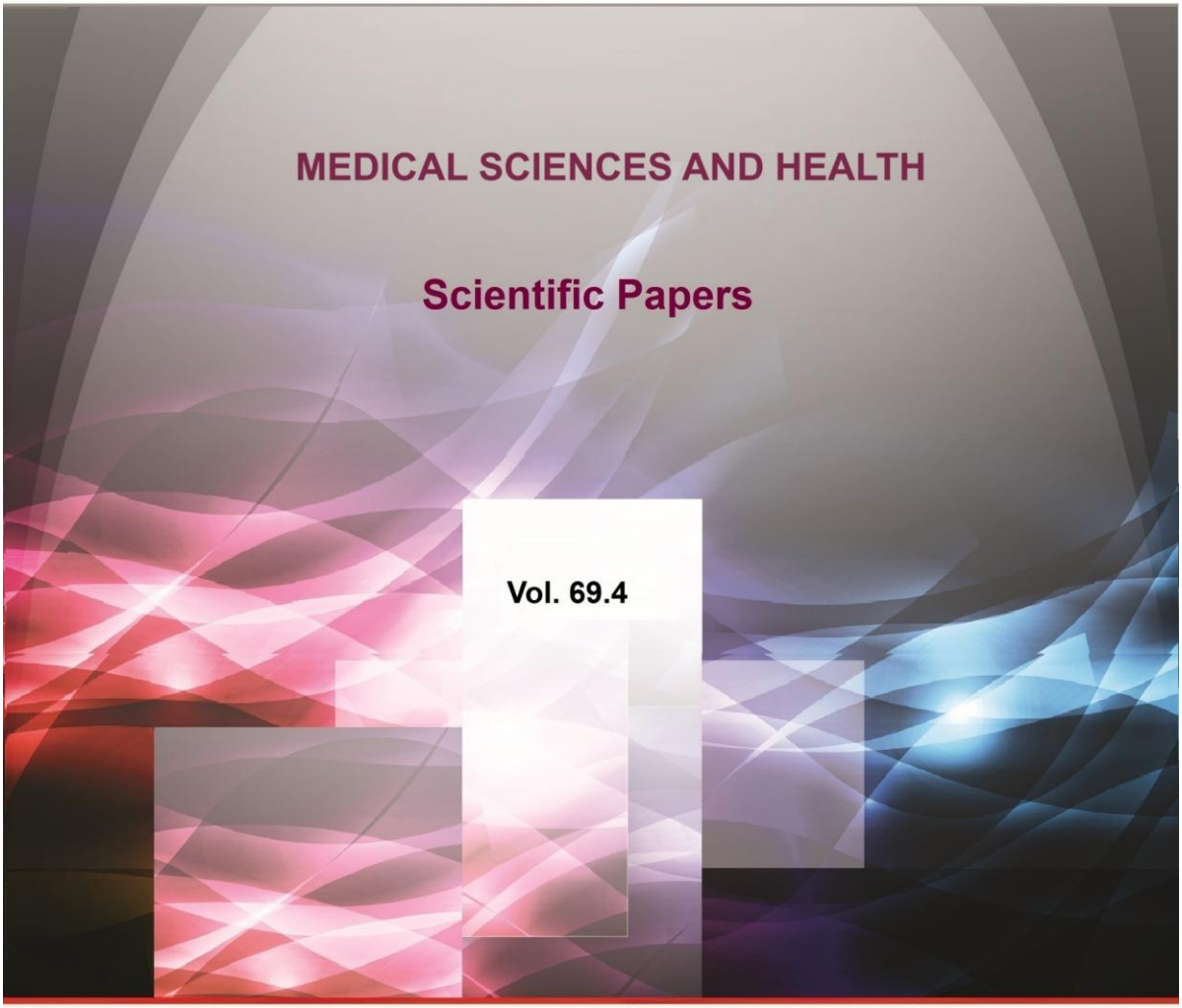

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CONTENTS

ANALYSIS OF THREE-DIMENSIONAL TOOTH MOVEMENT WITH FIXED APPLIANCE AND ALIGNER TREATMENT

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Abstract: Most people dream of having a perfect smile. However, some individuals avoid therapy with fixed orthodontic appliances for one reason: the brackets are visible and would interfere with some professions. Fortunately, there is a discreet way to straighten teeth – with invisible clear aligners**.**Thanks to numerous media and social media adverts promoting various orthodontic techniques and products for correcting malocclusions, patients can select several new modalities. One of the most potent uses of digital technology is Clear Aligner Therapy (CAT), in which stimulation is used to electronically program tooth movement. The main aim of the study was to show implementation of digital technology three-dimensional for assessment of tooth movement following different orthodontic therapy- classical orthodontic fixed appliance and aligners. Digital technologies are used in orthodontics as well; they provide computerized visual prediction of treatment outcomes. Planning, measurements, and stimulations are carried out on a precise 3D representation of the teeth, which is first obtained by digital models created from scans of plaster models or direct intraoral scans. The research was done in private dental office ("Albi Ortodent" Tetovo,N. Macedonia)and all patients with frontal toothcrowding in both jaws received treatment. Aligners and fixed orthodontic appliances were used for the patient's treatment. Digital system applications are used in orthodontics, where they provide computerized visual therapy outcome prediction.The average age was 14.5 years old, while the range of ages was 13–16.After analyzing the data, it was noted that for $F=3.94$ and $p<0.01$ ($p=0.002$) there is a significant difference between the values of the mesial-distal direction movement of the teeth included in the study.For $F=3.898$ and $p>0.05$ ($p=0.0599$) there is no significant difference between the values of movement in mesial-distal direction of the teeth treated with a fixed appliance and an aligner. According toPost Hoc Tests / Bonferroni test analysis, for $p>0.05$ ($p=0.0599$) there is no significant difference between the value of the mesial-distal direction movement of the teeth treated with a fixed appliance and an aligner.Clear aligners can produce outcomes that are clinically acceptable and potentially comparable to those obtained through fixed appliance therapy. They support improved oral hygiene practices, which in turn enhances oral and periodontal health. However, the current body of evidence does not affirm that aligners serve as an equally effective treatment modality when compared to the established gold standard of braces.
Keywords: Orthodontic 3D model; tooth movement; Orthodontic fixed appliances; Clear aligners; Geomagic software

1. INTRODUCTION

Patients have the option to select new modalities thanks to numerous media and social media adverts and promoting various orthodontic techniques and products for correcting malocclusions. One of the most potent uses of digital technology is Clear Aligner Therapy (CAT), in which stimulation is used to electronically program tooth movement. When teeth are given a target position via virtual planning, tracking their motions throughout therapy becomes crucial to the effectiveness of treatment (Haouili et al, 2020).

Digital overlays are a vital component of modern orthodontic methods for evaluating tooth mobility. Professionals can comprehend the potential and constraints of the mechanisms and technologies utilized in overlays by carefully evaluating and quantifying them (Haouili et al. 2020).

Advances in technology have transformed the field of orthodontics over time, greatly enhancing diagnostic and treatment planning (Grünheid et al, 2017; Castroflorio et al, 2023). The movement of teeth within the alveolar bone is known as orthodontic movement, and bone plays a significant role in restricting these motions. Because excessive orthodontic motions and torque loss can cause root resorption, gingival recession, and alveolar bone loss, which can worsen periodontal diseases, the orthodontist must respect the boundaries of the bone around the tooth (Queirós et al, 2024).

Cone beam computed tomography (CBCT) has made it possible to see bone and roots in orthodontics, which has made treatment planning easier and given a more realistic picture of the patient's teeth's ultimate position.(Gauer, 2011).

One of the most difficult aspects of orthodontic therapy with aligners, according to the Jiang et al (2021), is controlling root movement. Intraoral scanners and three-dimensional imaging have increased the potential for digital appliance production, treatment planning, and diagnosis (Castroflorio et al, 2023)The aim of the study was to show implementation of digital technology for three-dimensional tooth movement following different therapy modalities.
The main aim of the study was to show implementation of digital technology three-dimensional for assessment of tooth movement following different orthodontic therapy- classical orthodontic fixed appliance and aligners.

2. MATERIALS AND METHODS

The research was done in private dental office ("Albi Ortodent" Tetovo,N. Macedonia) and all patients with frontal teethcrowding in both jaws received treatment. Aligners and fixed orthodontic appliances were used for the patient's treatment. Digital system applications are used in orthodontics, where they provide computerized visual therapy outcome prediction.
Planning, measurements, and stimulations are carried out on a precise 3D representation of the teeth, which is first obtained by digital models created from scans of plaster models or direct intraoral scans. Intraoral and model scanned by intraoral and technical scanner. (Fig. No. 1) Serial 3D models obtained at various times can be registered and integrated into a single international coordinate system to measure tooth mobility. The effects of therapy between time periods have been measured using a variety of methods and software programs for digital 3D registration of virtual models and tooth movement measurements.

Figure No. 1. Initial state

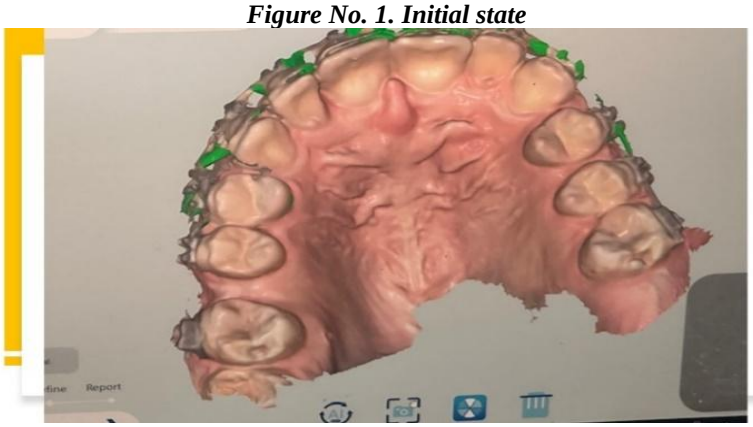

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Figure 2. A.Scanning model. B.Therapy design and plan. C Printed models

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Figure 3. Tooth movement planning

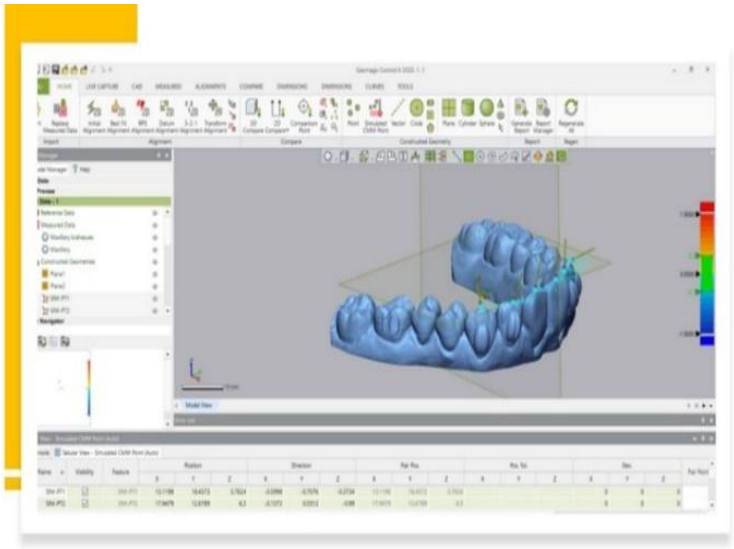

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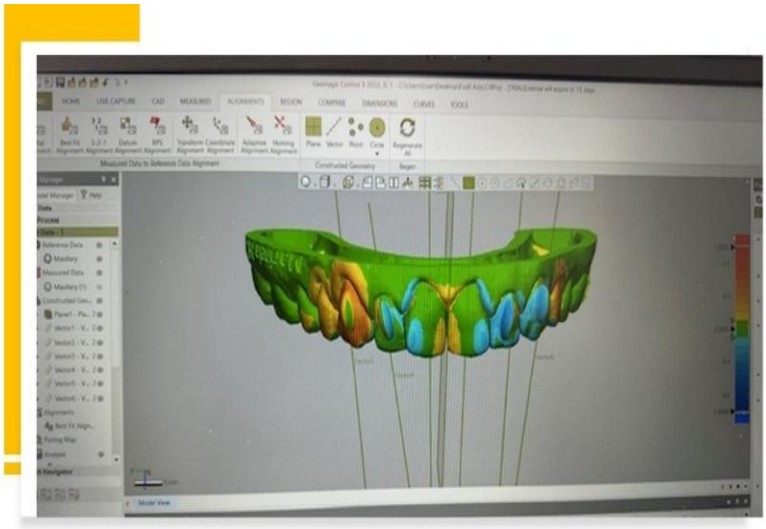
Figure 4. To examine dimensional deviations, the view compares a scanned object with a base model (reference).The degree of deviation is represented by the color scheme on the right, which goes from blue to red. Anegative deviation (distal movement) is indicated by blue, which means that there is excess or insufficientmaterial in the current model. A positive deviation (mesial movement) is indicated by red.Green's deviations are negligible or nonexistent, which is near to the nominal tolerance.



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3. RESULTS

After analysis the demographic data, it was noted that the average age was 14.5 years old, while the range of ages was betweenn13–16.

Table No. 1 shows descriptive statistics of the values (borderline values) of the mesial-distal direction in 48 teeth in the four quadrants of the maxilla and mandible. The values of the movement of the teeth in the mesial-distal

direction are presented in the table. After analyzing the data, it was noted that for F=3.94 and p<0.01 (p=0.002) there is a significant difference between the values of the mesial-distal direction movement of the teeth included in the study.

Tab. No. 1. Descriptive statistics of the values of the mesial-distal direction in 48 teeth in the four quadrants of the maxilla and mandible

Tooth: LS Means; Current effect: F (11, 24) =3,9382, p=,**00242** Effective hypothesis decomposition						
Cell No.	Teeth	DV_1 Mean	DV_1 Std.Err.	DV_1 -95,00%	DV_1 +95,00%	N
1	11	-8,7417	4,352871	-17,7256	0,2422	4
2	12	-13,8400	4,352871	-22,8239	-4,8561	4
3	13	-21,7783	4,352871	-30,7622	-12,7944	4
4	21	-1,8308	4,352871	-10,8147	7,1531	4
5	22	5,1133	4,352871	-3,8706	14,0972	4
6	23	11,0208	4,352871	2,0369	20,0047	4
7	31	-1,5750	4,352871	-10,5589	7,4089	4
8	32	-0,4300	4,352871	-9,4139	8,5539	4
9	33	-0,0625	4,352871	-9,0464	8,9214	4
10	41	0,7733	4,352871	-8,2106	9,7572	4
11	42	0,5708	4,352871	-8,4131	9,5547	4
12	43	0,5275	4,352871	-8,4564	9,5114	4

Source: authors

Table No. 2. shows descriptive statistics of the values (borderline values) of the mesial-distal direction movement in 48 teeth treated with a fixed appliance and an aligner. For F=3.898 and p>0.05 (p=0.0599) there is no significant difference between the values of the mesial-distal direction of the teeth treated with a fixed appliance and an aligner.

Table No. 2. Descriptive statistics of the values of the mesial-distal direction movement in 48 teeth treated with a fixed appliance and an aligner

Group; LS Means; Current effect: F(1, 24)=3,8985, p=,05994 Effective hypothesis decomposition						
Cell No.	Group	DV_1 Mean	DV_1 Std.Err.	DV_1 -95,00%	DV_1 +95,00%	N
1	Fixed appliance	-5,00208	1,777052	-8,66974	-1,33443	24
2	Aligner	-0,04000	1,777052	-3,70766	3,62766	24

Source: authors

Tab. No. 3. Post Hoc Tests / Bonferroni test

Bonferroni test; variable DV_1; Probabilities for Post Hoc Tests Error: Between MS = 227,37, df = 24,000			
Cell No.	Group	{1} -5,00	{2} -0,04
1	Fixed appliance		0,059944
2	Aligner	0,059944	

Source: authors

The results shown in table No. 3 refer to the Post Hoc Tests / Bonferroni test analysis. According to it, for $p>0.05$ ($p=0.0599$) there is no significant difference between the value of the mesial-distal direction of the teeth treated with a fixed appliance and an aligner.

4. DISSCUSION

The conducted research pointed to the fact, which is widely known, that with the help of orthodontic therapy, tooth movement occurs. With the help of both fixed orthodontic therapy and aligners, teeth move into the desired positions, which is confirmed by the results of our research, where significance was discovered.

The results of our research indicated that there is no significant difference between the effects caused using classic fixed orthodontic appliances and aligners.However, aligners are becoming more and more in demand compared to classic fixed orthodontic appliances due to their numerous advantages.

In a review published in 2014, Zeng et al. analyzed the differences between clear aligners and braces, finding only one relevant study. The authors concluded that there was insufficient evidence to validate the effectiveness of clear aligners compared to braces.

What can be observed in contemporary literature is the difference in context of which type of orthodontic treatment, the one with the help of orthodontic braces or the one with the help of aligners, is better. So some studies indicated that clear aligners were unable to treat malocclusion as effectively as braces,(Djeu et al, 2005;Kuncio et al, 2007; Pavoni et al, 2011; Grünheid et al, 2016; Ke et al, 2019) while another studies did not reveal any statistically significant differences between the two orthodontic devices.(Li& Zhang, 2015, Hannessy et al, 2016, Gu et al, 2017, Lanteri et al , 2018)

According to the findings of Ke et al. (2019), both clear aligners and braces successfully treat malocclusion. Clear aligners present certain advantages, such as enabling segmented tooth movement and reducing the length of treatment. Nevertheless, they are not as proficient as braces in achieving proper occlusal contacts, regulating tooth torque, and ensuring retention.

Aligner therapy, which are removable appliances, is extensively utilized in clinical practice as a more attractive and comfortable substitute for multi-attachment appliances (Macri et al., 2023). With ongoing technological advancements, there has been a shift towards more aesthetically focused orthodontic devices, and a significant number of adults are now seeking orthodontic treatment.

The main advantages of aligner include enhanced appearance and comfort, along with the convenience of removing the aligners for meals, effective tooth brushing, and flossing. A range of thermoplastic materials, or their combinations, are utilized in the thermoforming of aligners, such as polyvinyl chloride, polyurethane, polyethylene terephthalate, and polyethylene terephthalate glycol (Castroflorio, 2023).

Depending on the registration algorithm employed, registration software programs are utilized to quantify the amount of orthodontic tooth movement in digital orthodontics. Studies evaluating software programs' accuracy to compare therapy effects and efficacy are lacking in the scholarly literature (Haouili et al, 2020;Awadet al, 2018). The current study calculated the amount of tooth movement in the mesio-distal directions for the complete anterior dentition.

5. CONCLUSION

Clear aligners can produce outcomes that are clinically acceptable and potentially comparable to those obtained through fixed appliance therapy. They support improved oral hygiene practices, which in turn enhances oral and periodontal health. However, the current body of evidence does not affirm that aligners serve as an equally effective treatment modality when compared to the established gold standard of braces.

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