

Assessment of the Efficacy of Invisalign Aligners for Tooth Movement: A Clinical Study

Saurav Kumar^{1*} Nadira Hassan² Sushila Sah³ Taufique Anwer⁴ Rehan Ahmad Khan⁵ Sana Shaikh⁶

¹Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Mithila Minority Dental College and Hospital, Darbhanga, Bihar, India.

²Private Dental Practitioner, Ara, Bhojpur, Bihar, India.

³Private Dental Practitioner, Jharsuguda, Odisha, India.

⁴Private Dental Practitioner, Araria, Bihar, India.

⁵Private Dental Practitioner, Muzaffarpur, Bihar, India.

⁶Private Dental Practitioner, Hadapsar, Pune, Maharashtra, India.

ABSTRACT

Background: The present study was conducted to assess the efficacy of Invisalign® aligners for tooth movement.

Materials & Methods: 46 patients underwent a non-extractive orthodontic treatment with Nuvola® aligners. In all, pre-treatment (T0), real post-treatment (T1) and ideal post-treatment (TS) parameters were recorded.

Results: Out of 46 patients, males were 34 and females were 12. The mean torque (degree) in right canine at T0 was 12.4, at T1 was 11.5 and at TS was 11.6, in lateral incisor was 10.3, 8.7 and 9.3 at T0, T1 and TS respectively, in central incisor was 9.4, 7.6 and 9.1 at T0, T1 and TS respectively. The mean torque in left canine at T0 was 12.3, at T1 was 10.7 and at TS was 9.9, in lateral incisor was 9.2, 8.4 and 8.5 at T0, T1 and TS respectively, in central incisor was 8.6, 7.2 and 8.7 at T0, T1 and TS respectively. The difference was significant ($P < 0.05$). The mean torque (degree) in right canine at T0 was 14.3, at T1 was 11.7 and at TS was 11.6, in lateral incisor was 11.7, 8.6 and 8.5 at T0, T1 and TS respectively, in central incisor was 11.3, 9.8 and 9.4 at T0, T1 and TS respectively. The mean torque in left canine at T0 was 16.7, at T1 was 14.3 and at TS was 15.6, in lateral incisor was 8.9, 7.6 and 7.3 at T0, T1 and TS respectively, in central incisor was 9.4, 9.1 and 9.0 at T0, T1 and TS respectively. The difference was significant ($P < 0.05$).

Conclusion: Clear aligner system is capable of providing torque movements of the anterior teeth.

Keywords: Clear aligner, Torque, Invisalign.

INTRODUCTION

Kesling¹ first proposed the use of sequential thermoformed aligners for orthodontic tooth movement and Align Technology in 1997 developed this idea into a feasible treatment modality with the introduction of CAD/CAM technologies. Clear aligner therapy has experienced increasing diffusion. The Invisalign system was introduced to the orthodontic market as a system of treating mild malocclusions, such as minor crowding and space closure.² In the following years, the system

developed: different attachment designs and auxiliaries such as Precision Cuts and Power Ridges were designed to enable additional treatment of difficult malocclusions. According to the manufacturer, Invisalign® can effectively perform major tooth movements, such as bicuspid derotation up to 50 degrees and root movements of upper central incisors up to 4 mm. In reference to the literature, however, there is no consensus about the exact indications of this system's treatment.³

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*Correspondence Dr. Saurav Kumar.

Department of Orthodontics and Dentofacial Orthopedics, Mithila Minority Dental College and Hospital, Darbhanga, Bihar, India.

Email: dr.sauravmishra29@gmail.com

While levelling and aligning, intrusion, and bodily distalisation of upper molars of no more than 1.5 mm were demonstrated to be predictable movements, rotations, extrusion, and torque movements are difficult to achieve with clear aligners.⁴ In addition, most of the available studies are relative to the Invisalign system, but differences in the aligner's material properties and thickness the production process, the model's precision, and the position of the aligner's margin all have an effect on the final performance of the appliance.⁵ The present study was conducted to assess the efficacy of Invisalign® aligners for tooth movement.

MATERIALS & METHODS

The present study was conducted in the department of Orthodontics. It comprised of 46 patients of both genders. Ethical approval for the study was obtained before starting the study. All subjects were informed regarding the study and their consent was obtained. Data of subjects such as name, age, gender etc. was recorded. All subjects underwent a non-extractive orthodontic treatment with Nuvola® aligners. The Nuvola® system is designed to proceed through consecutive steps of a maximum of 12 aligners. After each step, new impressions were obtained to design a new setup and to move forward to the next treatment phase. The treatment plan required the presence of retention attachments for the buccal surfaces of the first and second premolars and the IPR of anterior teeth in order to achieve the correct dental alignment. Patients were instructed to wear their aligners for 22 hours per day. Aligners were replaced every 14 days. In all, pre-treatment (T0), real post-treatment (T1: at the end of the first phase of treatment after 12 aligners), and ideal post-treatment parameters were recorded. Results were tabulated and subjected to statistical analysis. P value less than 0.05 was considered.

RESULTS

Table I: Distribution of patients.

Total- 46		
Gender	Female	Male
Number	34	12

Table I shows that out of 46 patients, females were 34 and males were 12.

Table II: Assessment of torque in maxillary ridge.

Side	Teeth	T0	T1	TS	P value
Right	Canine	12.4	11.5	11.6	0.91
	Lateral incisor	10.3	8.7	9.3	0.05
	Central incisor	9.4	7.6	9.1	0.03
Left	Canine	12.3	10.7	9.9	0.04
	Lateral incisor	9.2	8.4	8.5	0.08
	Central incisor	8.6	7.2	8.7	0.91

Table II shows that mean torque (degree) in right canine at T0 was 12.4, at T1 was 11.5 and at TS was 11.6, in lateral incisor was 10.3, 8.7 and 9.3 at T0, T1 and TS respectively, in central incisor was 9.4, 7.6 and 9.1 at T0, T1 and TS respectively. The mean torque (degree) in left canine at T0 was 12.3, at T1 was 10.7 and at TS was 9.9, in lateral incisor was 9.2, 8.4 and 8.5 at T0, T1 and TS respectively, in central incisor was 8.6, 7.2 and 8.7 at T0, T1 and TS respectively. The difference was significant ($P < 0.05$).

Table III: Assessment of torque in mandibular ridge.

Side	Teeth	T0	T1	TS	P value
Right	Canine	14.3	11.7	11.6	0.04
	Lateral incisor	11.7	8.6	8.5	0.02
	Central incisor	11.3	9.8	9.4	0.01
Left	Canine	16.7	14.3	15.6	0.05
	Lateral incisor	8.9	7.6	7.3	0.01
	Central incisor	9.4	9.1	9.0	0.94

Table III shows that mean torque (degree) in right canine at T0 was 14.3, at T1 was 11.7 and at TS was 11.6, in lateral incisor was 11.7, 8.6 and 8.5 at T0, T1 and TS respectively, in central incisor was 11.3, 9.8 and 9.4 at T0, T1 and TS respectively. The mean torque (degree) in left canine at T0 was 16.7, at T1 was 14.3 and at TS was 15.6, in lateral incisor was 8.9, 7.6 and 7.3 at T0, T1 and TS respectively, in central incisor was 9.4, 9.1 and 9.0 at T0, T1 and TS respectively. The difference was significant ($P < 0.05$).

DISCUSSION

There is still an open debate about the predictability of clear aligner therapy, especially regarding complex tooth movements.⁶ While levelling and aligning, intrusion, and bodily distalisation of upper molars of no more than 1.5 mm were demonstrated to be predictable movements, rotations, extrusion, and torque movements are difficult to achieve with clear aligners. Some authors doubt that bodily movements (especially incisor torque) can be accomplished using removable plastic appliances.^{7,8} To generate the needed force systems, Invisalign® provides the use of an attachment or Power Ridge.⁹ The present study was conducted to assess the efficacy of Invisalign® aligners for tooth movement.

In present study, out of 46 patients, females were 34 and males were 12. Lombardo et al¹⁰ comparing planned and achieved tipping and rotation tooth movements in patients using another clear aligners system, found that orthodontic aligners are unable to achieve programmed movement with 100% predictability. In particular, although tipping movements were efficaciously achieved, especially at the molars and premolars, rotation of the lower canines was an unpredictable movement.

We found that mean torque in right canine at T0 was 12.4, at T1 was 11.5 and at TS was 11.6, in lateral incisor was 10.3, 8.7 and 9.3 at T0, T1 and TS respectively, in central incisor was 9.4, 7.6 and 9.1 at T0, T1 and TS respectively. The mean torque in left canine at T0 was 12.3, at T1 was 10.7 and at TS was 9.9, in lateral incisor was 9.2, 8.4 and 8.5 at T0, T1 and TS respectively, in central incisor was 8.6, 7.2 and 8.7 at T0, T1 and TS respectively. Tepedino et al¹¹ evaluated the predictability of Nuvola® aligner system in achieving torque movements of anterior teeth. Thirty-nine adult patients, who were consecutively treated with clear aligners, were retrospectively selected, and digital models pre-treatment (T0), post-treatment (T1) and the digital setup models (TS) were collected. Only the first phase of treatment made of 12 aligners was considered for the present study. Torque of anterior teeth was measured as labiolingual inclination on digital models at T0, T1, and TS using VAM software. No statistically significant difference was found for all the anterior teeth between predicted and achieved torque movements.

We found that mean torque in right canine at T0 was 14.3, at T1 was 11.7 and at TS was 11.6, in lateral incisor was 11.7, 8.6 and 8.5 at T0, T1 and TS respectively, in central incisor was 11.3, 9.8 and 9.4 at T0, T1 and TS respectively. The mean torque in left canine at T0 was 16.7, at T1 was 14.3 and at TS was 15.6, in lateral incisor was 8.9, 7.6 and 7.3 at T0, T1 and TS respectively, in central incisor was 9.4, 9.1 and 9.0 at T0, T1 and TS respectively. Simon et al¹² reviewed the tooth movements of 30 consecutive patients who required orthodontic treatment with Invisalign®. In all patients, one of the following tooth movements was performed: (1) Incisor Torque >10°, (2) Premolar derotation >10° (3) Molar distalization >1.5 mm. The groups (1)-(3) were subdivided: in the first subgroup (a) the movements were supported with the use of an attachment, while in the subgroup (b) no auxiliaries were used (except incisor torque, in which Power Ridges were used). All tooth movements were performed in a split-mouth design. To analyze the clinical efficacy, pre-treatment and final plaster cast models were laser-scanned and the achieved tooth movement was determined by way of a surface/surface matching algorithm. The results were compared with the amount of tooth movement predicted by ClinCheck®. The overall mean efficacy was 59% (SD = 0.2). The mean accuracy for upper incisor torque was 42% (SD = 0.2). Premolar derotation showed the lowest accuracy with approximately 40% (SD = 0.3). Distalization of an upper molar was the most effective movement, with efficacy approximately 87%.

The shortcoming of the study is small sample size.

CONCLUSION

Authors found that clear aligner system is capable of providing torque movements of the anterior teeth.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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