



Retrospective Assessment of Clinical Efficiencies of Clear Aligners in Managing Open Embrasures and Radiographic Root Angulations in Routine Orthodontic Therapies: An Original Research Study

Dr. Ruchi Saini¹, Dr. Tanjula Shair², Dr. Shehla Rafique³, Dr. Farooq Ahmad Dar⁴, Dr. Dinesh Kumar Maddhesia⁵, Dr. Reshu Jindal Goyal⁶

¹Associate Professor, Department of Orthodontics and Dentofacial Orthopedics, Subharti Dental College, Subharti University, Meerut, UP, India (Corresponding Author)

²Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics, Subharti Dental College, Subharti University, Meerut, UP, India

³Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics, Subharti Dental College, Subharti University, Meerut, U.P. India

⁴Dental Officer (Orthodontist), J & K Health Services, India

⁵Private Practitioner (Orthodontist), Uttarkashi, UK, India

⁶Assistant Professor, Department of Orthodontics and Dentofacial orthopedics, IDST, ModiNagar, Ghaziabad, UP, India

Corresponding Author: Dr. Ruchi Saini

(Received: 07 October 2023)

Revised: 12 November

Accepted: 06 December)

KEYWORDS

Aligners,
Esthetics,
Orthodontics,
Embrasures, Root
Angulations

ABSTRACT:

Background and Aim: Correction of esthetics is the key factor any orthodontic therapy. Latest advancements, newer materials and techniques are now available which offer maximum esthetics with minimum discomfort. Clear aligners are of latest orthodontic modality of such kind. However it has its own situational limitations and dilemmas. Hence, this retrospective study was conducted to assess the clinical efficiencies of clear aligners in managing open embrasures and radiographic root angulations in routine orthodontic therapies.

Materials & Methods: Total thirty patients were selected archives by random selection procedure. In this study, previous pre-treatment and post-treatment records of the patients were extensively explored. For all patients basic diagnostic records including OPG, Intraoral and extraoral photographs, digital models of dental arches were made. Mainly, ClinCheck and Dolphin imaging software were used. Clear Aligner was used to finish all cases. Open gingival embrasures were categorized under group 1 while radiographic root angulations were categorized under group 2. Results thus obtained was compiled and sent for necessary statistical analysis. P value less than 0.05 was considered significant ($p < 0.05$). **Results:** Statistical analysis was completed using statistical software Statistical Package for the Social Sciences version 22.0. In age range of 25-26 years, total 9 patients were seen with significant p value (0.02). In group 1, patients depicted clear evidence/occurrence of open gingival embrasures. It has showed significant p values (0.01). For group 2, patients depicted clear evidence/occurrence of radiographic root angulations. It did not show any significant p values (0.70). Two sample t- test assessment of mean score and standard deviation in both study groups confirmed significant and non significant values for group 1 and 2 respectively. **Conclusion:** It was concluded that orthodontic patients treated with clear aligners showed clear rise in incidence of open gingival embrasures in regular orthodontic therapies. On contrary, these orthodontic patients treated with clear aligners showed insignificant incidences of presence of radiographic root angulations.



Introduction

The prime focus of most of the orthodontic treatment is to maintain optimal esthetic. Anterior esthetic is most demanding and crucial too for managing for particular age and sex. Anterior esthetics is composed of several factors including gingival factor.¹⁻⁴ Gingiva and its components play an imperative role in smile and subjective confidence. Open gingival embrasure is most common clinical problem faced by patients. These are also called as black triangle. Literature has well evidenced about the etiology of these black triangles. Prime factors are pathologic and physiologic.⁵⁻⁹ Root angulations are mainly the distance jaw bone crest to inter-proximal contact region. These activities can eventually lead to the development if unwanted black triangles. Root angulations coupled with black triangles are also seen frequently with ongoing orthodontic treatment. With the introduction and usage of advanced material and techniques, these dilemmas have become more common. Clear aligners are one such advancement which has become the treatment of choice for most of the clinicians and researchers. Many researchers have also reported several clinical reports about performances of clear aligners.¹⁰⁻¹⁶ Therefore, considering all these factors, this retrospective study was conducted to assess the clinical efficiencies of clear aligners in managing open embrasures and radiographic root angulations in routine orthodontic therapies.

Materials & Methods

This study was planned and conducted to assess the outcomes of the usage of clear aligners in terms of open embrasures and radiographic root angulations. Total thirty patients were selected from archives of the patient records. The study was designed on cohort basis in which previous pre-treatment and post-treatment records of the patients were extensively explored. This exercise was particularly done for patients treated with clear aligners only. Inclusion criteria included patients with intact and fully erupted permanent second molar. It also included healthy periodontium with no sign of clinical periodontitis like bleeding of probing and teeth mobility. Exclusion criteria included clinical signs of clinical periodontitis and history of previous orthodontic treatment. For all patients basic diagnostic records including OPG, Intraoral and extraoral photographs, digital models of dental arches. All patients were being

explained about the study in details. Accordingly, informed consent was obtained from all participating patients. Both male and female patients were included in the study in the age of >18 years. All privacy and other details were kept confidential for all studied patients. Digital models of maxillary and mandibular arches were transformed and prepared by renowned software. Predominantly, ClinCheck and Dolphin imaging software were used. Patients with routine orthodontic diagnosis were studied for their outcomes along with Clear Aligner (Align Technology, CA, USA). Two prime objectives ; open embrasures and radiographic root angulations were studied on digital models and data collected accordingly. Relative incidences of open gingival embrasures and radiographic root angulations were studied in detail to outline results. Open gingival embrasures were categorized under group 1 while radiographic root angulations were categorized under group 2. Results thus obtained was compiled and sent for necessary statistical analysis. P value less than 0.05 was considered significant ($p < 0.05$).



Fig.1 Clear Aligner

Statistical Analysis and Results

All relevant data were sent for statistical analysis using statistical software Statistical Package for the Social Sciences version 22.0 (IBM Inc., Armonk, New York, USA). The screened data was subjected to suitable statistical tests to obtain p values, mean, standard deviation, chi-square test, standard error and 95% CI. Initial outcomes of the results were very crucial. Table 1 and Graph 1 shows estimated about age & gender based statistical description of contributing patients. In age range of 25-26 years, total 9 patients were seen with significant pvalue (0.02). Other age groups like 18-20 years, 21-22 years, 23-24 years, did not exhibit significant p values. Table 2 depicts about fundamental statistical description with level of significance evaluation using pearson chi-square test. It was for



group 1 wherein patients depicted clear evidence/occurrence of open gingival embrasures. It has showed significant p values (0.01). Table 3 showed about fundamental statistical description with level of significance evaluation using pearson chi-square test. It was for group 2 wherein patients depicted clear evidence/occurrence of radiographic root angulations. It did not show any significant p values (0.70). Table 4 is

about basic statistical interpretations of between Groups, within Groups and cumulative [ANOVA Analysis, for Group 1 & 2]. Results were highly significant (0.001) and reliable too. Table 5 was about two sample t- test assessment of mean score and standard deviation in both study groups. Results confirmed significant and non significant values for group 1 and 2 respectively.

Table 1: Age & gender based statistical description of contributing patients

Age Group (Yrs)	Male	Female	Total	P value
18-20	2	1	3	0.94
21-22	5	4	9	0.80
23-24	6	3	9	0.12
25-26	7	2	9	0.02*
Total	20	10	30	*Significant
*p<0.05 significant				

Table 2: Fundamental statistical description with level of significance evaluation using pearson chi-square test [Group 1: For patients depicting clear evidence/occurrence of open gingival embrasures]

Groups	+	-	Mean	Std. Deviation	Std. Error	95%CI	Pearson Chi-Square Value	df	Level Significance (p value)
Group 1	19	11	1.118	0.981	0.893	1.92	1.346	2.0	0.01*

Table 3: Fundamental statistical description with level of significance evaluation using pearson chi-square test [Group 2: For patients depicting clear evidence/occurrence of radiographic root angulations]

Groups	+	-	Mean	Std. Deviation	Std. Error	95%CI	Pearson Chi-Square Value	df	Level Significance (p value)
Group 2	9	21	1.898	0.673	0.142	1.44	1.133	1.0	0.70

Table 4: Basic statistical interpretations of Between Groups, Within Groups and Cumulative [ANOVA Analysis, for Group 1 & 2]

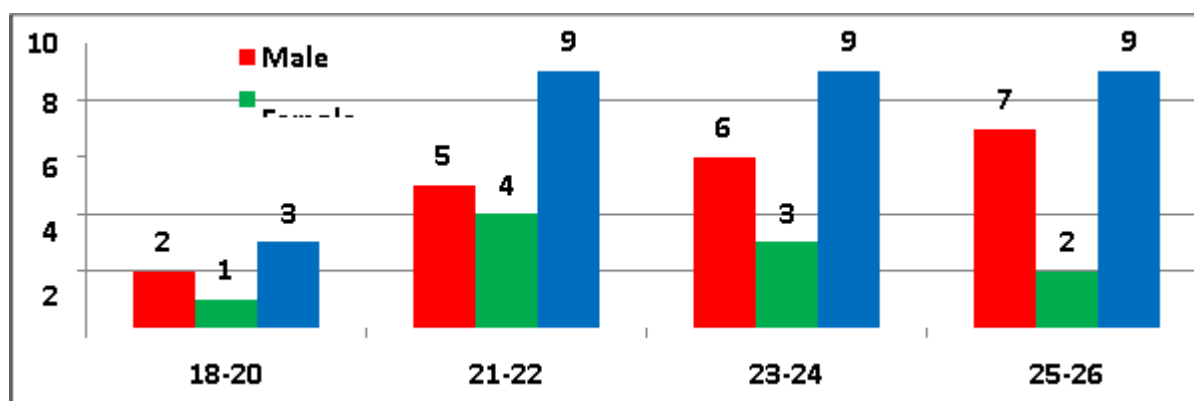
ANOVA					
Parameters	Degree of Freedom	Sum of Squares Σ	Mean Sum of Squares $m\Sigma$	F	Level of Significance



Between Groups	2	1.012	1.097	1.1	0.001*
Within Groups	13	1.103	0.342	-	
Cumulative	110.10	3.803	*p<0.05 significant		

Table 5: Two sample t- test assessment of mean score and standard deviation in both studygroups

Two sample t- test	Group I		Group II	
	Mean Score	SD	Mean Score	SD
Values	1.118	0.981	1.898	0.673
P-value	0.001 (Significant)		0.820 (Non- Sig.)	

**Graph 1:** Patient's demographic allocation and related details

Discussion

Literature has well evidenced about several materials those have been experimented for optimal esthetics in the field of orthodontics. Condo and associates have studied about mechanical properties of teeth aligners and their relative effects on the pertinent changes during oral permanence and performance. They also agreed that clear aligners have some deleterious effect on the optimal gingival health.¹⁷ Phan and colleagues have also studied in detail about clinical limitations of Invisalign. They also found very imperative outcomes wherein they confirmed the role of clear aligner in the development of black triangles. This finding was somewhat in agreement of our results and outcomes.¹⁸ Kandasamy and other workers have extensively worked out to explore the changes in interdental papillae heights following alignment of anterior teeth. Their results showed insignificant role of aligners in the overall esthetics and smile of patients.¹⁹ Martina and other pioneer researchers have searched for cytotoxicity of different thermoplastic materials for clear aligners. They found very mild cytotoxic involvement of aligners

therefore they recommended the clinical use of clear aligners in non prone situations.²⁰ Nemec and associates have worked to explore the behavior of human oral epithelial cells grown on Invisalign. They noticed and confirmed that clear aligners play significant role in the initial differentiations and migration of the human oral epithelial cells.²¹ Chow and other workers have studied in detail about the factors associated with the appearance of gingival papillae. Like our studies results they also concluded that clear aligner have their significant role in the development of gingival embrasures.²² Literature have also evidenced for similar outcomes in other research studied published worldwide.²³⁻²⁸

Conclusion

Within the limitations of the study, it is concluded that orthodontic patients treated with clear aligners showed clear rise in occurrence of open gingival embrasures in routine orthodontic therapies. The associated outcomes were highly significant also. On contrary, same orthodontic patients treated with clear aligners showed



insignificant incidences of presence of radiographic root angulations. These results were non significant. Our study was based on retrospective model however some upcoming future prospective studies on larger samples and wider parameters are expected.

References

- Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi CL. Periodontal health during clear aligners treatment: a systematic review. *Eur J Orthod.* 2015;37(5):539–43.
- Chhibber A, Agarwal S, Yadav S, Kuo CL, Upadhyay M. Which orthodontic appliance is best for oral hygiene? A randomized clinical trial. *Am J Orthod Dentofacial Orthop.* 2018;153(2):175–83.
- Dai FF, Xu TM, Shu G. Comparison of achieved and predicted tooth movement of maxillary first molars and central incisors: first premolar extraction treatment with Invisalign. *Angle Orthod.* 2019;89(5):679–87.
- Haouili N, Kravitz ND, Vaid NR, Ferguson DJ, Makki L. Has Invisalign improved? A prospective follow-up study on the efficacy of tooth movement with Invisalign. *Am J Orthod Dentofacial Orthop.* 2020;158(3):420–5.
- Sharma K, Saini R, Srivastava A, Narendran N, Batra P. Treatment of Class II Div 1 Malocclusion patient using Churro Jumper- A flexible fixed functional appliance: A case Report. *Dental Expressions* 2016;1(4):45-50.
- Batra P, Saini R, Chopra A. Treatment of Temporomandibular disorder using NTI- TSS (nociceptive trigeminal inhibition-tension suppression system- A case Report. *Dental Expressions* 2014;1(2):10-13.
- Saini R, Abdullah MY, Singhal G, Sharma N, Lukose A, Kurup AA. A Retrospective Assessment of Alterations in Gingival Crevicular Fluid (GCF) after applying Fixed Orthodontic Appliances: An Original Research Study. *J Cardiovascular Disease Research* 2021;12(4):647-653.
- Saini R, Abdullah MY, Thakur N, Kashyap V, Nandakumar GD, Ghosh A. An In vitro Evaluation of Effects of Different Mouthwashes on Frictional Resistance of Orthodontic Bracket and Archwire: An Original Research Study. *J Res Adv Dent* 2021;12(5):1-4.
- Rahalkar A, Saini R, Punia K, Thakur N, Agrawal D, Sharma V. Assessment of effect of fixed orthodontic treatment on gingival health: An observational study. *International Journal of Health Sciences.* 2022;6(S1):6014–6018.
- Satija A, Singh H, Akshita, Priya K, Saini R, Gupta G. Comparative Evaluation of Different Mechanical Plaque Control Methods in patients undergoing Fixed Orthodontic Therapy: A Retrospective Study. *J Cardiovascular Disease Research* 2021;12(5):46-51.
- Saini R, Goyal RJ, Jain R, Taunk T, Bopche P, Agrawal SR. To evaluate the occurrence and variables impacting post operative pain after root canal treatment in orthodontically corrected teeth: an original research study. *NeuroQuantology* 2022;20(11):1234-1241.
- K Toshi T, Vashishtha M, Chaddha A, Galagali SA, Gopalakrishnan D, Saini R, et al. Alterations in integumental facial dimensions after orthodontic treatment. *J Pharm Bioall Sci* 2021;13:S1474-7.
- Saini R, Thakur N, Jindal Goyal R, et al. Analysis of Smile Aesthetic Changes With Fixed Orthodontic Treatment. *Cureus* 14(12): e32612.
- Saini N, Ahluwalia R, Gupta R, Saini JK, Chugh T, Saini R. Craniofacial morphology of patients having Obstructive Sleep Apnoea- A cephalometric study. *Pharmaceutical Negative Results* 2022;13(6):215-220.
- Maree A, Kerr B, Weir T, Freer E. Clinical expression of programmed rotation and uprighting of bilateral winged maxillary central incisors with the Invisalign appliance: a retrospective study. *Am J Orthod Dentofacial Orthop.* 2022;161(1):74–83.
- Galan-Lopez L, Barcia-Gonzalez J, Plasencia E. A systematic review of the accuracy and efficiency of dental movements with Invisalign®. *Korean J Orthod.* 2019;49(3):140–9.
- Condo R, Pazzini L, Cerroni L, et al. Mechanical properties of “two generations” of teeth aligners: change analysis during oral permanence. *Dent Mater J.* 2018;37(5):835–42.
- Phan X, Ling PH. Clinical limitations of Invisalign. *J Can Dent Assoc.* 2007;73(3):263–6.
- Kandasamy S, Goonewardene M, Tennant M. Changes in interdental papillae heights following alignment of anterior teeth. *Aust Orthod J.* 2007;23(1):16–23.
- Martina S, Rongo R, Bucci R, Rationale AV, Valletta R, D’Anto V. In vitro cytotoxicity of different thermoplastic materials for clear aligners. *Angle Orthod.* 2019;89(6):942–5.
- Nemec M, Bartholomaeus HM, M HB, et al. Behaviour of human oral epithelial cells grown on Invisalign(®) SmartTrack(®) material. *Mater (Basel).* 2020;13(23):5311.
- Chow YC, Eber RM, Tsao YP, Shotwell JL, Wang HL. Factors associated with the appearance of gingival papillae. *J Clin Periodontol.* 2010;37(8):719–27.



23. Ikeda T, Yamaguchi M, Meguro D, Kasai K. Prediction and causes of open gingival embrasure spaces between the mandibular central incisors following orthodontic treatment. *Aust Orthod J*. 2004;20(2):87–92.
24. Joshi A, Suragimath G, Zope SA, Ashwinirani SR, Varma SA. Comparison of gingival biotype between different genders based on measurement of dentopapillary complex. *J Clin Diagn Res*. 2017;11(9):Zc40-zc45.
25. Yassir YA, Nabbat SA, McIntyre GT, Bearn DR. Clinical effectiveness of clear aligner treatment compared to fixed appliance treatment: an overview of systematic reviews. *Clin Oral Investig*. 2022;26(3):2353–70.
26. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. *J Periodontol*. 1992;63(12):995–6.
27. Lee DW, Kim CK, Park KH, Cho KS, Moon IS. Non-invasive method to measure the length of soft tissue from the top of the papilla to the crestal bone. *J Periodontol*. 2005;76(8):1311–4.
28. Madariaga ACP, Bucci R, Rongo R, Simeon V, D'Anto V, Valletta R. Impact of fixed orthodontic appliance and clear aligners on the periodontal health: a prospective clinical study. *Dent J (Basel)*. 2020;8(1):4.