

Assessment of Knowledge and Attitude of Orthodontists & Post Graduate Students of Orthodontics and Dentofacial Orthopedics Regarding Aligner Biomechanics amongst Gujarat – A Questionnaire Study

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(Received: 12 October 2025

Revised: 10 November

Accepted: 03 December)

KEYWORDS

Clear aligners,
Aligner
Biomechanics,
Orthodontists.

ABSTRACT:

Aim: To assess knowledge and attitude of Orthodontists & Post Graduate students of Orthodontics and Dentofacial Orthopedics regarding Aligner biomechanics amongst Gujarat state. **Study Design:** The Questionnaire was designed by Principal investigator. After content validation, by six faculties of Dept. of Orthodontics & Dentofacial Orthopedics, K.M Shah Dental College & Hospital, the questionnaire was sent to minimum of 305 participants i.e. 152 Orthodontists & 152 Post graduate students via WhatsApp message (online survey). The non responders were reminded after 3 days and responses were collected with waiting period of 3 days till next 2 reminders. After minimum of 67 responses per group i.e. Orthodontists & Post graduate students were achieved, the study was considered to be completed. The assembled survey data was further evaluated to conclude the result. **Results:** A questionnaire-based survey was conducted to evaluate the knowledge and attitude of orthodontists and postgraduate students regarding aligner biomechanics. Around 67% orthodontists estimated overall treatment accuracy to be above 70%, whereas the 64% postgraduates perceived it to range between 50–70%. Bucco-lingual movement was identified as the most accurately achieved tooth movement by both groups, while intrusion was deemed the least predictable. Power grip devices were predominantly used by orthodontists for extrusion, while postgraduate responses indicated a broader range of applications. The influence of aligner thickness on the moment-to-force ratio was acknowledged by the majority of respondents. Both groups agreed that attachments function through a combination of displacement and force, fulfilling roles such as retention, force generation, and anchorage. Horizontal pliers were most commonly used for power ridge formation, and "tear drop plier" was the most frequently recognized alternate name for the keyhole plier. Postgraduates preferred scalloped aligner margins positioned 2 mm above the gingival zenith, whereas orthodontists showed varied preferences. Both groups emphasized on Virtual C chains primarily utilized for closure of anterior spaces. SmartTrack aligners were credited by 50% postgraduates for enhanced stress relaxation, while 40% orthodontists attributed their advantage to improved material hardness. For retention purposes, 75% orthodontists preferred horizontal attachments with bevel, whereas 42% postgraduates favoured those without bevel. During derotation without attachments, orthodontists commonly reported extrusive forces, while postgraduates identified intrusive



forces to be the unintended force. Both groups emphasized the importance of attachment placement and IPR timing during staging. The term “leading tooth” was interpreted by 75% orthodontists as the first tooth to move during staging, while 42% postgraduates associated it with the tooth that moves the most. Aligners were primarily considered to deliver interruptive forces by 75% orthodontists, while postgraduates provided varied responses. Posterior intrusion was the most reported effect of bite blocks by majority of participants. Although most participants indicated the use of staggered staging for Molar Distalization, this contrasts with existing literature, which supports its use for extraction space closure. Majority of participants enlightened on Precision wings predominantly used for mandibular advancement and were most commonly located on the buccal surface. **Conclusion:** The present survey concluded that both orthodontists and postgraduate students in Gujarat have varied understanding of aligner biomechanics. They agreed on force application, attachment roles, and staging. In contrast, their opinion was vary in clinical perceptions and preferences regarding tool usage, staggered staging, power grip device and attachment usage. The findings highlight the need for continued education and align clinical practice to the knowledge with evidence-based guidelines to bridge existing knowledge gaps.

1. Introduction

In recent years, Orthodontists and patients have increasingly favored Clear aligner treatment.¹ Compared to fixed orthodontic appliances, clear aligners provide an esthetic and comfortable treatment experience, facilitate oral hygiene, cause less pain, reduce the number & duration of appointments and require fewer emergency visits.^{1,2} However, the expense in production, dependency on patient cooperation, and the inability to treat certain malocclusions limit the usage of clear aligners.²

Aligner therapy works by sequentially moving the teeth in small amount with consecutive aligners to reach to final orthodontic outcomes. This technique of moving teeth using successive thermoplastic appliance was contributed to Orthodontic community by Kesling.³ Initially the manual method of aligner production method was used which includes manual repositioning of teeth within cast, wax setting and production of vacuum formed retainers is carried out.² Clear Aligner system CA (Scheu Dental, Germany) is an example of aligner systems requiring a manual setup wherein the system programmed for measuring the tooth movement.² Lately, Invisalign is the best-known aligner system using CAD-CAM technology. Invisalign devices have been introduced in 1997 by Kelsey Wirth and Zia Chisti, the founder of Align Technology.^{4,5,6} This 3D technology allows to visualize and move the teeth in virtual model.⁴ The aligner shape, the desired movement

for each tooth & mechanical principles to accomplish this movement are determined by Clincheck software.⁷

Aligners provide 0.25 to 0.3mm tooth movement over week, wherein the aligner has to be worn for atleast 20-22 hours a day. Aligners are usually made of either PET-G (Polyethylene terephthalate glycol) & TPU (Thermoplastic polyurethane).^{4,7} The aligner material has evolved from being single layered to multiple layered.⁵ The soft layer imparts property of elastic deformation proving easy seating of aligner whereas the hard layer ensures strength & durability.⁵ The thickness of aligner material may vary (0.020-inch, 0.025-inch, or 0.030-inch). The thicker material provides better control on tooth movement. There are multiple parameters like material properties, material thickness, amount of activation, specific designed attachments, overcorrection & Staging of OTM (Orthodontic Tooth Movement) influences the biomechanical properties of aligner ultimately affecting the treatment modality.^{1, 8} Initially these aligners were used only for providing mild to moderate orthodontic movements^{8, 9} but incorporation of attachments and auxiliaries has made treatment of complex cases also possible. Pressure points & power ridges could be incorporated to apply desired force. ² Even after so much evolution the problems like root paralleling, extrusion & rotation are difficult to achieve. Thus, Smart force attachments for Invisalign system are introduced. These are Small composite buldges designed by Clincheck software to provide



favorable force for the desired tooth movement.² Thus, understanding the mechanics of tooth movements using aligners plays a crucial role for better results. Thorough knowledge regarding the patient selection and sequencing is equally important.

The clinicians usually use clear aligner based on their own clinical experience, expert opinion and limited published evidence-based results.⁹ Majorly previous articles have incorporated the knowledge and attitude of general dentists regarding aligner therapy and patients' perspective on awareness about clear aligners.⁷ Majorly 76% of the general dentists have a brief knowledge regarding the clear aligners.⁹ There are very few articles describing about the biomechanics of aligners. Various studies were done to check for the efficiency of aligners showing wage results for various orthodontic tooth movement, thus leaving a doubt amongst the clinician specifically orthodontists and post graduate students in orthodontics and dentofacial orthopedics regarding effectiveness of the appliance.⁸ Thus, this questionnaire study becomes a requirement to stock their current state knowledge regarding the biomechanics of aligners.

2. Need of the study

After appraising the literature till 17-08-2024 from PubMed, Google Scholar and Research Gate, majorly there are Literature review regarding the Clear Aligner therapy & very few articles¹⁰ regarding the effectiveness of Aligners. Also, the previous Questionnaire covers the knowledge and attitude of aligners of orthodontists and general dentists.⁹ During Aligner therapy to achieve the best result; adequate knowledge regarding the Patient selection, staging of treatment & Aligner Biomechanics is crucial. No evident article is present assessing the knowledge & attitude on Aligner Biomechanics amongst the Orthodontists & Post Graduates within Gujarat state. Thus, there becomes a necessity to conduct a survey to assess the knowledge & attitude of regarding Aligner biomechanics of Orthodontists & Post graduate students in the field of Orthodontics and Dentofacial Orthopedics in Gujarat state.

Research Hypothesis

For every Orthodontist / Post Graduate student in the field of the Orthodontics & Dentofacial

Orthopedics their accomplishment of the desired treatment result by aligner therapy varies based on their level of education regarding aligner biomechanics. Thus, present study will be conducted to quantitatively assess knowledge and attitude amongst orthodontists and post graduate students regarding aligner biomechanics.

3. Aims and Objectives

Aim: To assess knowledge and attitude of Orthodontists & Post Graduate students of Orthodontics and Dentofacial Orthopedics regarding Aligner biomechanics amongst Gujarat state.

Objectives

- To assess the knowledge regarding aligner biomechanics amongst Orthodontists
- To assess the attitude regarding aligner biomechanics amongst Orthodontists
- To assess the knowledge regarding aligner biomechanics amongst Post Graduates
- To assess the attitude regarding aligner biomechanics amongst Post Graduates

4. Material and Methodology

Study Design

1. **Place of the study:** Department of Orthodontics and Dentofacial Orthopaedics, K.M. Shah Dental College & Hospital, Sumandeep Vidyapeeth Deemed to be University.
2. **Source of the sample:** Practicing Orthodontist & Post Graduate Students.
3. **Study Approval:** Study Approval was taken from Sumandeep Vidyapeeth Institutional Ethical Committee.
4. **Time Scale of the Study:** Study was started after obtaining SVIEC approval and was completed within 6 Months from the date of Study Approval.
5. **Selection Criteria:**

Inclusion Criteria

- i. IOS Certified Orthodontist & Post Graduate Students
- ii. Orthodontists & Post Graduate Students willing to participate in the study
- iii. Orthodontists & Post Graduate students, practicing or studying respectively, within Gujarat state.



Exclusion Criteria

- i. Non IOS Certified Orthodontists & Post Graduate Students
- ii. General Dentists practicing Orthodontics.
- iii. Practicing Orthodontists & Post graduate students of Orthodontics & Dentofacial Orthopedics Specialization not using Whatsapp.

6. Study Design: Cross sectional Study

7. Sample Size Estimation: Based on the article titled "A survey on the knowledge and perception of orthodontists clear aligner systems among general dentists" and the proportion used to measure the parameter usage of aligner system in Indian market by general dentists is 78.2% with an alpha of 5%. The corresponding z value is -1.95996398454005. Using the above formula with the minimum percentage difference to be deemed clinically significant as 7%, the sample size required for accurate result would be 134 for the study with 67 sample per group. To achieve the average online survey response rate of 44 % and above, as per the meta-analysis by Meng-Jia Wu et al¹⁴ the questionnaire was sent to approximately 305 participants 152 per group.

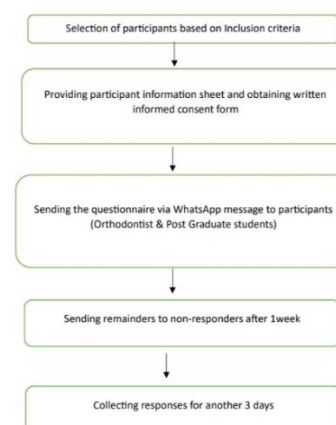
8. Sample description: Following the Convenience sampling method the questionnaire was sent to minimum of 152 Orthodontists and 152 Post Graduate students of Orthodontics & Dentofacial Orthopedics having IOS registration based on the recent Members directory of IOS and those who consent to participate in the study were included.

5. Methodology

The participants were selected according to the inclusion criteria and were equally bifurcated into groups of Practicing Orthodontists and Post Graduate students. The questionnaire was sent to all the selected participants (152 per group) via google form link through WhatsApp message. Non responding participants were reminded after a week and responses were collected for another 3 days. Again, if the response is not obtained after 3 days the reminder was sent again in similar manner for next 2 times with response waiting period of 3 days. After that the responses were not considered valid. The responses from the participants were collected until the average online survey response

rate (44%) was achieved with minimum 134 responses i.e. 67 from each group. The obtained responses were further subjected to statistical analysis to conclude the results.

Flowchart



Questionnaire

Assessment of Knowledge and Attitude of Orthodontists & Post Graduate students of Orthodontics and dentofacial orthopedics regarding Aligner Biomechanics amongst Gujarat- a Questionnaire Study

1. According to you how much percentage of overall treatment accuracy will be achieved for predicted tooth movement?
 - a. <20%
 - b. 20-50%
 - c. 50-70%
 - d. >70%
2. The most accurately achieved predicted tooth movement is?
 - a. Intrusion
 - b. Extrusion
 - c. Bucco-lingual movement
 - d. Translational movement
3. Which one of the following predicted tooth movements is least accurately achieved?
 - a. Intrusion
 - b. Extrusion
 - c. Translational movement
 - d. Rotation



4. Power Grip Pressure Relief Device could be used for which of the following movement?
 - a. Intrusion
 - b. Extrusion
 - c. Sagittal Correction
 - d. De-Rotation of tooth
5. According to you will there be any effect of aligner material thickness on Moment to Force Ratio?
 - a. Yes
 - b. No
6. Attachments in Clear Aligner therapy work on which mechanism?
 - a. Displacement driven tooth movement
 - b. Force driven tooth movement
 - c. Both a & b
 - d. None of the above
7. Which of the following functions are fulfilled by incorporating Attachments?
 - a. Generate force for the tooth movement
 - b. Provide Retention
 - c. Anchorage consideration
 - d. All of the above
8. Which of the plier is usually used for making Power ridges?
 - a. Hole puch Plier
 - b. Horizontal Plier
 - c. Vertical Plier
 - d. Key hole Plier
9. What is the other name for Key hole plier?
 - a. Hole puch Plier
 - b. Tear Drop Plier
 - c. Vertical Plier
 - d. Dimple Plier
10. Which of the margin position of Clear Aligner would be accurate when used with attachments?
 - a. Scalloped margin
 - b. Straight margin at gingival zenith
 - c. Straight margin 2mm above gingival zenith
 - d. Straight margin 1mm above gingival zenith
11. Virtual C Chain can be used for which of the following procedure?
 - a. Premolar extraction space closure
 - b. Residual anterior space closure
 - c. Molar Distalization
 - d. Molar Uprighting
12. Which of the following property of Conventional Aligner is overcome by SmartTrack aligners?
 - a. Initial Insertion force
 - b. Stress relaxation
 - c. Hardness of material
 - d. Elastic modulus of material
13. For retention purpose which type of attachment is preferable in Clear Aligner therapy?
 - a. Horizontal Attachment without bevel
 - b. Horizontal Attachment with bevel
 - c. Vertical Attachment
 - d. "T" attachment
14. In Gingivally beveled Horizontal attachment what would be advantageous for extrusion of anterior teeth?
 - a. Increased Angle between tooth and active surface of attachment
 - b. Decreased Angle between tooth and active surface of attachment
 - c. Tooth and active surface of attachment are parallel to each other
 - d. No difference will be found with angle
15. Which type of unintended force is exerted while derotating tooth without attachment in Clear Aligner therapy?
 - a. Intrusive force
 - b. Extrusive force
 - c. Mesial tipping force
 - d. Distal tipping force
16. During Staging the important areas to be looked at are
 - a. Attachment placement
 - b. Timing of IPR
 - c. Both of above
 - d. Doesn't matter



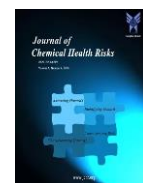
17. What is referred as “Leading Tooth” during Aligner therapy
- Tooth that moves first
 - Tooth that is moved the most
 - Tooth moving first in each and every staging
 - There is no such specification
18. Type of forces exerted by Aligners
- Continuous force
 - Intermittent force
 - Interruptive force
 - Combination of forces
19. The “Bite block” effect seen in aligner indicates
- Extrusion of Posterior teeth
 - Intrusion of Posterior teeth
 - Sagittal Correction
 - Intrusion of Anterior teeth
20. Staggered Stage treatment protocol could be effectively used for which of the treatment
- Residual anterior space closure
 - Molar Distalization
 - Extraction Space closure
 - Extrusion of Anterior teeth
21. “Precision Wings” are incorporated in aligners for
- Molar Distalization
 - Mandibular Advancement
 - Arch Expansion
 - Deep bite correction
22. “Precision Wings” are incorporated on which surface of the aligner
- Buccal surface
 - Lingual surface
 - Occlusal surface
 - Proximal surface

6. Observations & Result

Present research included total 134 responses amongst which 67 responses from Orthodontists and 67 responses from Post graduate students for each question. Question wise Orthodontists & Post-graduate responses were as follows

Table 1. Responses from Orthodontists & Post Graduate students for each question.

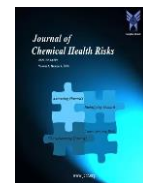
Questions					
1. % of Overall treatment accuracy		<20%	20-50%	50-70%	>70%
	Ortho	0%	16.70%	16.70%	66.70%
	PG's	0%	18.20%	63.60%	18.20%
2. Most accurately achieved OTM		Intrusion	Extrusion	Bucco-lingual movement	Translational movement
	Ortho	16.70%	0%	83.30%	0%
	PG's	8.30%	25%	58.30%	8.30%
3. Least accurately achieved OTM		Intrusion	Extrusion	Translational movement	Rotation
	Ortho	66.70%	0%	0%	33.30%
	PG's	33.30%	25%	8.40%	33.30%



4. Use of Power Grip Pressure Device		Intrusion	Extrusion	Sagittal Correction	De-rotation of tooth
	Ortho	0%	66.70%	0%	33.30%
	PG's	16.70%	41.70%	25%	16.70%
5. Effect of Aligner Thickness on M:F Ratio		Yes	No		
	Ortho	83.30%	16.70%		
	PG's	100%	0%		
6. Mechanism of Attachment		Displacement driven	Force Driven	Both	none
	Ortho	33.30%	0%	66.7%	0%
	PG's	25%	16.70%	58.30%	0%
7. Function fulfilled by Attachment		Generate force	Provide retention	Anchorage consideration	all
	Ortho	16.70%	0%	0%	83.30%
	PG's	8.30%	33.30%	0%	58.30%
8. Plier used for Power ridges formation		Hole punch plier	Horizontal Plier	Vertical Plier	Key hole Plier
	Ortho	0%	60%	0%	40%
	PG's	0%	75%	0%	25%
9. Other name for Key hole plier		Hole punch Plier	Tear Drop plier	Vertical Plier	Dimple Plier
	Ortho	25%	50%	0%	25%
	PG's	16.70%	33.30%	8.30%	41.70%
10. Margin Position of Aligner with attachment		Scalloped margin	SM at gingival zenith	SM 2mm above GZ	SM 1mm above GZ
	Ortho	50%	0%	50%	0%
	PG's	25%	0%	66.70%	8.30%



11. Usage of Virtual C Chain		Premolar extraction space	Residual anterior space	Molar distalization	Molar uprighting
	Ortho	40%	60%	0%	0%
	PG's	25%	50%	8.30%	16.70%
12. Conventional aligner property overcome by SmartTrack aligners		Initial Insertion force	Stress relaxation	Hardness of material	Elastic modulus of material
	Ortho	20%	20%	40%	20%
	PG's	16.70%	50%	16.70%	16.70%
13. Preferred attachment for Retention purpose		Horizontal attachment w/o bevel	Horizontal attachment with bevel	Vertical attachment	T attachment
	Ortho	25%	75%	0%	0%
	PG's	41.70%	25%	0%	33.30%
14. Advantageous positioning of Gingivally beveled attachment for Extrusion		Increased angle	Decreased angle	active surface and attachment parallel to each other	No difference
	Ortho	25%	75%	0%	0%
	PG's	33.30%	41.70%	16.70%	8.30%
15. Unintended force while derotation w/o attachment		Intrusive force	Extrusive force	Mesial tipping force	Distl tipping force
	Ortho	33.30%	66.70%	0%	0%
	PG's	50%	16.70%	25%	8.30%
16. Important areas during Staging		Attachment placement	Timing of IPR	Both	Doesn't matter
	Ortho	25%	0%	75%	0%
	PG's	25%	0%	66.70%	8.30%



17. What is referred as Leading Tooth		Tooth that moves first	Tooth that moves most	Tooth moving first in each staging	No such Specification
	Ortho	0%	25%	75%	0%
	PG's	16.70%	41.70%	25%	16.70%
18. Type of force by Aligners		Continuous force	Intermittent force	Interruptive force	Combination force
	Ortho	0%	25%	75%	0%
	PG's	25%	33.30%	25%	16.70%
19. Bite Block Effect ?		Extrusion of posterior teeth	Intrusion of Posterior teeth	Sagittal correction	Intrusion of Anterior teeth
	Ortho	0%	80%	0%	20%
	PG's	27.30%	63.60%	0%	9.10%
20. Staggered Stage treatment protocol is used for		Residual anterior space closure	Molar Distalization	Extraction space closure	Extrusion of Anterior teeth
	Ortho	0%	75%	25%	0%
	PG's	16.70%	50%	8.30%	25%
21. Usage of Precision wings		Molar distalization	Mandibular Advancement	Arch Expansion	Deep bite correction
	Ortho	0%	66.70%	0%	33.30%
	PG's	8.30%	58.30%	8.30%	25%
22. Surface where the Precision wing is incorporated		Buccal Surface	Lingual surface	Occlusal surface	Proximal surface
	Ortho	66.70%	0%	33.30%	0%
	PG's	41.70%	33.30%	8.30%	16.70%

Ortho: Orthodontists; PG's : Post Graduate students; w/o: without; SM: Straight margin; GZ: Gingival Zenith; OTM: Orthodontic tooth movement; M:F : Moment to Force ratio.



7. Discussion

In recent years, clear aligner therapy gained significant popularity among patients due to its esthetic appeal and convenience. The concept of aligner-based treatment was first introduced by Dr. Harold Kesling in 1946, who proposed the use of thermoplastic tooth positioners to achieve tooth alignment^{6,11}. Since then, advancements such as the incorporation of attachments, power ridges, and newer materials have expanded their application beyond simple cases to include more complex orthodontic movements.

Clear aligners offer several advantages, including improved patient comfort and compliance, enhanced oral hygiene, better periodontal health, and greater esthetic acceptance⁶. They are generally considered a clinician-friendly treatment option. However, studies show varying levels of knowledge and confidence in aligner use across practitioners. Goswami et al¹¹ reported limited knowledge of aligner systems among general dentists, restricting them mostly to treating mild malocclusions. Zakirulla et al⁹ similarly found moderate awareness of Invisalign among general dentists in Saudi Arabia. In contrast, Veeran et al⁶ observed improved understanding of clear aligners among dental practitioners, regardless of whether they actively practiced aligner therapy.

Several literature review by Alami et al¹, Shristi et al³, Tamer et al⁸, and Sunegha et al¹⁰ have highlighted the importance of understanding the biomechanics of aligner therapy. Shivam et al⁵ particularly emphasized the significance of staging in aligner biomechanics. A thorough grasp of these concepts is crucial to achieving predictable and successful treatment outcomes. Yet, no previous study has comprehensively assessed the knowledge and attitude regarding aligner biomechanics among orthodontists and postgraduate students prompting this present research focused on practitioners in Gujarat.

This study revealed notable differences between Orthodontists and Post graduate students in terms of their understanding of aligner biomechanics. Orthodontists believed that >70% of predicted orthodontic tooth movement (OTM) can be achieved with aligners, whereas Post graduate students estimated this range to be between 50–70%. However, both groups agreed that Bucco-lingual movement is the most

accurately achieved, while intrusion is the least predictable findings supported by Charalampakis et al¹⁵. Additionally, 33.3% Post graduate students identified rotation as the least accurately achieved movement, which aligns with findings by Lombardo et al¹⁶ and Grunheid et al¹⁷.

In terms of auxiliary use, 66.7% Orthodontists and 41.7% Post graduate students reported using the Power Grip Pressure Relief Device for extrusion, consistent with previous literature^{1,18–20}. Awareness of the intrusive force generated during derotation without attachments was relatively low—only 33.3% Orthodontists and 50% Post graduate students correctly identified this effect^{18–20}. Both groups demonstrated limited awareness regarding the intermittent force nature of aligners, which diminishes upon appliance removal^{18–20}. Only 25% Orthodontists and 33.3% Post Graduate students recognized this characteristic.

Participants widely agreed that attachments serve three functions: generating force, enhancing retention, and providing anchorage. However, preferences varied with 75% Orthodontists preferred horizontal attachments with a bevel for retention & 41.7% Post graduate students preferred horizontal attachments without a bevel. Knowledge of biomechanical advantage regarding reduced angle gingivally bevelled horizontal attachment between the tooth and active surface to enhance extrusion, was higher among orthodontists (75%) than PGs (41.7%)^{18–20}. Awareness of the bite block effect leading to posterior intrusion by aligners was high in both groups (80% orthodontists, 63.6% Post graduate students)^{18–20}.

Regarding plier usage, 60% of orthodontists and 75% of PGs preferred horizontal pliers for forming power ridges. However, knowledge of the alternate name of the keyhole plier as the “tear drop plier” was moderate (50% orthodontists, 33.3% post graduate students)^{18–20}.

In terms of aligner margin design, 50% Orthodontists and 66.7% Post graduate students favoured a straight margin 2 mm above the gingival zenith, which is known to provide enhanced retention even in the absence of attachments¹⁰. Both groups demonstrated moderate awareness of Virtual C-chains, with 60% Orthodontists and 50% Post graduate students recognizing their use in residual anterior space closure.



Awareness of SmartTrack material offering enhanced stress relaxation was limited. Only 20% Orthodontists and 50% Post graduate students identified this property correctly^{18–20}.

Knowledge regarding staging protocols especially the importance of attachment placement and IPR timing was present in 75% Orthodontists and 66.7% Post graduate students⁵. The concept of the “leading tooth”, demarcated as the tooth that initiates movement during each stage, was understood by 75% Orthodontists but only 25% Post graduate students. Understanding of the staggered treatment protocol i.e. a sequencing method used for extraction space closure by alternating between canine and incisor retraction was poor.³ Only 25% Orthodontists and 8.3% Post graduate students were familiar with it.

Regarding mandibular advancement using precision wings, awareness was moderate among both groups i.e. 66.7% Orthodontists and 58.3% Post graduate students. However, knowledge of the location of incorporation; buccal surface of aligners; was more prevalent among orthodontists (66.7%) than Post graduate students (41.7%)³.

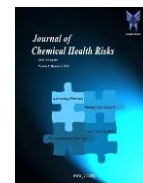
Overall, the study reflects a relative understanding of aligner biomechanics among both groups, though orthodontists displayed deeper clinical insight in areas such as staging, force application, and auxiliary use. These findings align with previous studies^{3,11} suggesting that knowledge is enhanced with improved clinical experience and along with education.

8. Conclusion

The present survey concluded that both orthodontists and postgraduate students in Gujarat have varied understanding of aligner biomechanics. They agreed on force application, attachment roles, and staging. In contrast, their opinion was vary in clinical perceptions and preferences regarding tool usage, staggered staging, power grip device and attachment usage. The findings highlight the need for continued education and align clinical practice to the knowledge with evidence-based guidelines to bridge existing knowledge gaps.

9. References

1. Liu J-Q, Zhu G-Y, Wang Y-G, Zhang B, Wang S-C, Yao K, et al. Different biomechanical effects of clear aligners in bimaxillary space closure under two strong anchorages: finite element analysis. *Prog Orthod.* 2022;23(1):41.
2. Tamer İ, Öztaş E, Marşan G. Orthodontic treatment with clear aligners and the scientific reality behind their marketing: A literature review. *Turk J Orthod.* 2019;32(4):241–6.
3. Mehta S, Patel D, Yadav S. Staging orthodontic aligners for complex orthodontic tooth movement. *Turk J Orthod.* 2021;34(3):202–6.
4. Kulkarni G, Garg A, Jain S and Jain SR. Clear Aligners: An insight to Biomechanics. *Int. J. Adv. Res.* 11(06), 771-782
5. Kundal S. Aligners: The science of clear orthodontics. *Int J Dent Med Spec.* 2020;7(1).
6. Veeran S, Navas R, Arasappan R, Subramani R, Soundarajan S, Saravanan N. Assessment of knowledge, attitude and practice regarding clear aligners among dental practitioners: a cross-sectional survey-based study. *Int J Dent Med Sci Res.* 2008;6(3):264–270.
7. Shivlani V, Niranjane P, Paul P. Assessment of awareness and perceptions of healthcare professional graduates regarding the use of clear aligners in orthodontic treatment. *Cureus.* 2023;15(10):e46348.
8. Moutawakil AEL. Biomechanics of aligners: Literature review. *Adv Dent Oral Health.* 2021;13(5).
9. Zakirulla M, Al Shehre RAM, Al Hosainah AM, Alamer HMA, Alhamood NAA, Alharthi DSM, Alqhatani AS, Alqahtani FMH, Alaamri AA, Aldail SA, Alammari AAM, Alqahtani AMM, Alsalem HM, Alzahrani NM. Dentist's knowledge and attitude towards using Invisalign in orthodontic treatment. *J Res Med Dent Sci.* 2022;10(10):109–113.
10. Savignano R, Valentino R, Razionale AV, Michelotti A, Barone S, D'Antò V. Biomechanical effects of different auxiliary-aligner designs for the extrusion of an upper central incisor: A finite element analysis. *J Healthc Eng.* 2019; 2019:9687127.



11. Goswami DN, Ansari N, Arun AV, Mahendra S, Chandrashekar BS, Raju AS, et al. A survey on the knowledge and perception of orthodontic clear aligner systems among general dentists. *Journal of Contemporary Orthodontics*. 2024;8(2):181–9.
12. Wu, M.-J., Zhao, K., & Fils-Aime, F.(2022) Response rate of online survey in published research: A meta-analysis. *Computers in Human Behaviour Reports*,7(100206), 100206.
13. Lynn MR. Determination and quantification of content validity. *Nurs Res*. 1986;35(6):382–5.
14. Wu MJ, Zhao K, Fils-Aime F. Response rates of online surveys in published research: a meta-analysis. *Computers in Human Behavior Reports*. 2022 Aug;7:100206.
15. Charalampakis O, Iliadi A, Ueno H, Oliver DR, Kim KB. Accuracy of clear aligners: A retrospective study of patients who needed refinement. *Am J Orthod Dentofacial Orthop* 2018;154(1):47–54.
16. Lombardo L, Arreghini A, Ramina F, Huanca Ghislanzoni LT, Siciliani G. Predictability of orthodontic movement with orthodontic aligners: a retrospective study. *Prog Orthod* 2017;18(1):35.
17. Grunheid T, Loh C, Larson BE. How accurate is Invisalign in nonextraction cases? Are predicted tooth positions achieved? *Angle Orthod* 2017;87(6):809–15
18. Glaser B. *The Insider's Guide to Invisalign Treatment: A Step-by-Step Guide to Assist You with Your ClinCheck Treatment Plans*. 3L Publishing; 2017.
19. Tai S. *Clear Aligner Technique*. Hanover Park, IL: Quintessence Publishing Co, Inc; 2018.
20. Nanda R, Castroflorio T, Garino F, Ojima K, editors. *Principles and Biomechanics of Aligner Treatment*. 1st ed. St. Louis: Elsevier; 2021.