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Evaluation of Knowledge and Attitude Related to in- House Clear Aligner Treatment Planning among Orthodontists and Post Graduate Students in Gujarat- A Questionnaire Study

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KEYWORDS

In-house clear aligners, orthodontic biomechanics, digital treatment planning, questionnaire study, knowledge and attitude, Gujarat.

ABSTRACT:

Background: In-house clear aligner therapy (CAT) has emerged as a viable and cost-effective alternative to commercial aligner systems, offering clinicians greater control over treatment planning and fabrication. However, its successful implementation requires a thorough understanding of digital workflows, biomechanics, and material properties. This study aimed to evaluate and compare the knowledge and attitudes of orthodontists and postgraduate (PG) students in Gujarat regarding in-house clear aligner treatment planning.

Materials and Methods: A descriptive, cross-sectional questionnaire-based study was conducted among 276 participants (138 orthodontists and 138 PG students). A validated 19-item questionnaire assessed knowledge of aligner biomechanics, staging sequences, attachment design, malocclusion management, material properties, and perceived advantages and limitations of in-house aligners. Content validity was established (S-CVI/Ave = 0.99), and reliability was confirmed via test–retest (ICC = 0.92) and internal consistency (Cronbach's α = 0.89). Data were analyzed using descriptive statistics.

Results: Both groups demonstrated strong foundational knowledge, with majority correctly identifying the ideal rotation per aligner as 2° (Orthodontists: 68.1%, PGs: 68.8%), preferring vertical rectangular attachments with occlusal bevel for retention (60.1% each), and power ridges for torque control (Orthodontists: 60.9%, PGs: 58.7%). Sequential distalization and mesialization were preferred for Class II and III corrections, respectively. Cost efficiency and clinical independence were recognized as the primary advantages (Orthodontists: 63.8%, PGs: 64.5%), while reduced predictability of complex movements was the main disadvantage (Orthodontists: 58.0%, PGs: 59.4%). Staging sequential tooth movements was identified as the most challenging aspect (Orthodontists: 61.6%, PGs: 56.5%).

Conclusion: Orthodontists and PG students in Gujarat possess sound theoretical knowledge and positive attitudes toward in-house clear aligner systems. However, concerns regarding staging complexity and movement predictability highlight the need for enhanced training in digital treatment planning and biomechanics to optimize clinical outcomes.

1. Introduction

Over the past two decades, clear aligner therapy (CAT) has evolved into a widely accepted and aesthetically preferred alternative to traditional fixed orthodontic appliances, particularly those placed on the labial surfaces of the teeth.[1] Originating with the advent of the Invisalign system developed by Align Technology in Santa Clara, California, this mode of orthodontic treatment has witnessed significant technological advancements and widespread adoption. Today, multiple CAT systems are available, each offering unique features aimed at improving treatment efficacy, patient comfort, and overall satisfaction. What began as a solution primarily suited for correcting mild dental misalignments in adults has expanded its clinical applications to include the management of increasingly complex orthodontic cases. More recently, a notable shift has occurred with

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the emergence of direct-to-consumer (DTC) aligner systems, which are marketed directly to patients and often operate without the direct supervision of dental professionals.[1] This development has sparked both interest and concern within the orthodontic community, raising important questions about safety, effectiveness, and the role of professional oversight in orthodontic care.In parallel with the growth of commercial aligner systems, a new model of delivering aligner therapy known as in-house clear aligners has emerged. In-house aligners are designed, planned, and fabricateddirectly by orthodontists within their own clinical or institutional settings, without outsourcing to external laboratories. This approach has been facilitated by the widespread availability of intraoral scanners, orthodontic CAD software, and affordable 3D printing technologies.

The process begins with obtaining a digital scan of the patient's dentition, followed by virtual treatment planning using specialized software. The teeth are digitally moved in stages according to the clinician's biomechanical objectives. Intermediate digital models are then 3D printed, and clear thermoplastic sheets are vacuum-formed or pressure-formed over these models to create the aligners. This workflow allows the clinician to directly control every aspect of treatment, from the sequence of tooth movement to the selection of materials and the incorporation of auxiliaries such as attachments or elastics.

Compared with commercial systems, in-house aligners offer several potential advantages. They can significantly reduce the overall cost of treatment by eliminating laboratory fees, making orthodontic care more accessible to patients and economically viable for practitioners. Turnaround time is greatly reduced, as aligners can be fabricated immediately after treatment planning without the delays associated with shipping and external processing. Mid-course corrections and refinements can be implemented promptly without incurring additional costs or waiting periods. The treating orthodontist retains full control over biomechanical planning, including attachment design, force vectors, and staging sequences, which may result in more efficient and personalized treatment outcomes. Furthermore, in an academic environment, in-house aligner production serves as a valuable educational tool for postgraduate students, providing them with hands-on experience in digital workflows, biomechanical planning, material selection, and fabrication techniques—skills that are often abstracted away in commercial systems.

With the increasing accessibility of intraoral scanners, advanced orthodontic software, and cost-effective three-dimensional printing technologies, in-house clear aligner systems have become a feasible and attractive option for both private practices and educational institutions. Their potential to combine clinical autonomy, cost efficiency, and tailored biomechanics positions them as a valuable alternative to commercial aligner systems, provided that the clinician has a thorough understanding of orthodontic principles, digital design, and material properties to ensure optimal treatment outcomes.

This Study Aims to Evaluate the Knowledge and Attitude of Orthodontists and Postgraduate Students in Gujarat Related to In-House Clear Aligner Treatment Planning Through a Questionnaire study.

2. Material And Methods

This cross-sectional questionnaire-based study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth Deemed to be University, Piparia, Vadodara, Gujarat. The study duration was 45 days following approval from the Sumandeep Vidyapeeth Institutional Ethical Committee (SVIEC).

Study Design

The study was designed as a descriptive, questionnaire-based cross-sectional survey.

Study Population

The study participants included IOS-registered orthodontists and postgraduate students in Gujarat. Their contact details, including email IDs and phone numbers, were obtained from the IOS directory.

Sample Size Calculation

The sample size was calculated based on a previously published study by Meade et al. (2023), which reported that 77.3% of orthodontists provided clear aligner therapy in their practice. Using this proportion ($p = 0.773$), with a 95% confidence level ($Z = 1.96$) and a 7% margin of error ($e = 0.07$), the minimum sample size was calculated as 138 participants per group. Accordingly, the final sample included 138 orthodontists and 138 postgraduate students.

Selection Criteria

Inclusion Criteria:

- IOS-registered orthodontists and postgraduate students willing to provide informed consent.

Exclusion Criteria:

- Non-IOS registered orthodontists and postgraduate students.
- General dental practitioners practicing orthodontics.

- IOS-registered orthodontists and postgraduate students who did not provide consent.

Questionnaire Development and Validation

The questionnaire was initially designed by the principal investigator and co-investigators. Content validity was assessed by five experts from the Department of Orthodontics and Dentofacial Orthopaedics, who rated each item on a 4-point Likert scale. The Content Validity Index (CVI) was calculated, yielding an S-CVI/Ave score of 0.99, indicating excellent content validity.

Test–retest reliability was assessed by administering the questionnaire twice to 28 participants (20% of the sample) at a 7-day interval. The intraclass correlation coefficient (ICC = 0.92, 95% CI: 0.86–0.96, $p < 0.001$) demonstrated excellent stability. Internal consistency was confirmed with Cronbach's alpha ($\alpha = 0.89$). Construct validity was assessed using exploratory factor analysis (EFA) with principal component analysis (PCA) and Varimax rotation, which confirmed sampling adequacy (KMO = 0.84) and extracted four factors explaining 68.4% of the variance.

Data Collection Procedure

The final validated questionnaire was circulated electronically via Google Forms, and the link was shared with eligible participants through WhatsApp. Non-responders were sent up to three reminders at 5-day intervals. Data collection continued for one month, and responses were automatically recorded in Google Sheets before being exported for analysis.

Validated Questionnaire

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1. **What is the ideal degree of rotation programmed per Aligner?**
   A. 2°
   B. 1°
   C. 3°
   D. 1.5°
2. **Which attachment design is most effective for Aligner retention?**
   A. Vertical rectangular with occlusal bevel
   B. Horizontal rectangular with occlusal bevel
   C. Vertical rectangular with gingival bevel
   D. Horizontal rectangular with gingival bevel
   E. Any Other, Please Specify….
3. **Which attachment position on clinical crown offers best retention?**
   A. 2 mm from gingival margin
   B. Middle of the clinical crown
   C. 2 mm from occlusal surface
   D. 1mm from gingival margin
   E. Any Other, Please Specify….
4. **Which is the most effective strategy for the torque planning in Upper Incisor?**
   A. Rectangular vertical attachments with sequential 2°–3° torque per Aligner.
   B. Ellipsoid Gingival attachments with single step torque programming
   C. Power Ridges
   D. Programming 5° torque per aligner using 1 mm PET-G material
   E. Any other Strategy, Please Specify….
5. **How do you typically approach Angle's Class II Division 1 malocclusion using Aligners?**
   A. Sequential Distalization of upper arch with optimized anchorage and attachments
   B. Simultaneous En-masse Distalization of upper arch with class II elastics / TADs
   C. Extractions
   D. Mandibulae Advancement Therapy and / or Maxillary Setback
   E. Any other Approach, Please Specify….
6. **How do you typically approach Angle's Class III malocclusion using Aligners?**
   A. Sequential Mesialization of upper arch with optimized anchorage and Attachments
   B. Simultaneous En-masse Mesialization of upper arch with class III elastics / TADs
   C. Extractions
   D. Maxillary Advancement Therapy and / or Mandibular Setback
   E. Any other Approach, Please Specify…
7. **Which aligner material property do you consider most critical for efficient and controlled tooth movement over long-term wear?**
   A. Optical Clarity
   B. High Modulus of Elasticity with Low Stress Relaxation
   C. Formability
   D. Biodegradability
   E. Spring Back
8. **In your opinion, which type of attachment offers the most predictable control for extruding a lateral incisor with minimal crown rotation?**
   A. Horizontal bevelled rectangular
   B. Ellipsoid passive
   C. Vertical rectangular
   D. Only Aligner grip / No Attachment
   E. Any other Approach, Please Specify….

9. **What is your preferred approach for Deep bite correction using in-house Aligner?**
   A. Anterior bite ramps and gradual incisor Intrusion
   B. Hybrid mechanics using micro implants with Aligner
   C. Posterior extrusion using attachment and elastics
   D. Simultaneous Anterior intrusion and Posterior extrusion
   E. Any other Approach, Please Specify….
10. **What is your preferred approach for Open bite correction using In-House Aligner?**
   A. Posterior intrusion using bite ramps with optimized staging
   B. Anterior extrusion using attachments
   C. Anterior extrusion using Box Elastic with Precision cuts
   D. Simultaneous Anterior extrusion and Posterior intrusion
   E. Any other Approach, Please Specify….
11. **What is your preferred approach for Posterior Cross bite correction using In-House Aligner?**
   A. Incorporation of Buccal expansion in planning stage in software only
   B. Combination of Cross elastics with precision cuts or bonded Buttons
   C. Rapid Maxillary Expansion followed by In-house aligners
   D. Slow Maxillary Expansion followed by In-house aligners
   E. Any other Approach, Please Specify….
12. **Which is your preferred sequence of tooth movement while planning Aligner staging in in-House Aligner System?**
   A. Expansion and derotation → Vertical control → Sagittal correction → Torque and root control → Finishing
   B. Vertical control → Expansion and derotation → Sagittal
   Correction → Torque and root control → Finishing
   F. Sagittal correction → Torque and root control → Expansion
   And derotation → Vertical control → finishing
   G. Torque and root control → Expansion and derotation →
   Vertical control → Sagittal correction → Finishing
   H. Any other preferred sequence, Please Specify….
13. **According to you, which is the most common cause of aligner tracking loss?**
   A. Attachment design mismatch
   B. Short clinical crowns and undercuts
   C. Complex staging
   D. Aligner distortion during thermoforming
   E. Poor patient compliance
14. **According to you, which is the most common limitation while planning buccal expansion (>4 mm) in the upper arch?**
   A. Soft tissue compression / Injury
   B. Aligner Material Fatigue / Damage
   C. Unpredictable crown tipping without significant root control
   D. Incidence of fenestration and dehiscence
   E. Any other, Please Specify….
15. **What is your preference regarding aligners margin designing and position?**
   A. Scalloped supragingival
   B. Scalloped equigingival
   C. Straight supragingival
   D. Straight equigingival
   E. Any other, Please Specify….
16. **Which is your preferred approach to plan severe crowding cases?**
   A. IPR
   B. Extractions
   C. Expansion
   D. A + C
   E. B + C
17. **According to you most difficult step in in-house Aligner Planning?**
   A. Planning of Sequential Staging for complex tooth movements
   B. Planning of biomechanically efficient attachment shapes and positions
   C. Planning of Anchorage to avoid unwanted tooth movements
   D. Integrating hybrid mechanics (e.g., Elastics, TADs, MARPE)
   E. Any other, Please Specify….
18. **According to you, most preferred advantage of In-house Aligners over Commercial Aligners is?**
   A. Complete control over digital staging and fabricating customized biomechanically tailored individual treatment plan
   B. Flexibility in aligner fabrication and refinements, enabling faster mid-course corrections for speedy treatment
   C. Cost-efficiency and independence from third-party labs, making aligner therapy more accessible and sustainable in practice
   D. Ability to design case-specific attachments and auxiliaries for better biomechanical control
   E. Any other, Please Specify….

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19. According to you, most preferred Disadvantage of In-house Aligners Over Commercial Aligners?

A. Inability to generate optimized multi-surface attachments and precision force vectors due to limited AI-based biomechanics in in-house software
B. Lack of access to layered or proprietary aligner materials with controlled force degradation and memory effects
C. Reduced predictability of complex tooth movements (e.g., root torque, bodily translation, intrusion) due to material limitations and manual staging
D. Increased probability of undesired reciprocal movements or anchorage loss due to absence of advanced staging algorithms and movement coordination
E. Any other, Please Specify…

Statistical Analysis

The collected data were tabulated and analyzed using descriptive statistics. Frequencies and percentages were calculated to summarize responses.

3. Result

A total of 276 participants were included in the study, comprising 138 orthodontists and 138 postgraduate (PG) students. Descriptive statistics of their responses to the questionnaire are summarized below.

Table no 1: Descriptive Statistics of Responses to the Questionnaire by Orthodontists

Question	Option	Frequency (Orthodontists)	Percentage (Orthodontists)
Q1	A. 2°	94	68.1
Q1	B. 1°	15	10.9
Q1	C. 3°	15	10.9
Q1	D. 1.5°	14	10.1
Q2	A. Vertical rect. occl. bevel	83	60.1
Q2	B. Horizontal rect. occl. bevel	9	6.5
Q2	C. Vertical rect. ging. bevel	15	10.9
Q2	D. Horizontal rect. ging. bevel	14	10.1
Q2	E. Other	17	12.3
Q3	A. 2mm ging.	15	10.9
Q3	B. Middle crown	70	50.7
Q3	C. 2mm occl.	18	13.0
Q3	D. 1mm ging.	13	9.4
Q3	E. Other	22	15.9
Q4	A. Rectangular attachments	16	11.6
Q4	B. Ellipsoid gingival	11	8.0
Q4	C. Power ridges	84	60.9
Q4	D. 5° torque PETG	14	10.1
Q4	E. Other	13	9.4
Q5	A. Sequential distalization	85	61.6
Q5	B. En-masse distalization	14	10.1

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Q5	C. Extractions	11	8.0
Q5	D. Mand. Adv/Max. Setback	16	11.6
Q5	E. Other	12	8.7
Q6	A. Sequential mesialization	84	60.9
Q6	B. En-masse mesialization	14	10.1
Q6	C. Extractions	17	12.3
Q6	D. Max. Adv/Mand. Setback	9	6.5
Q6	E. Other	14	10.1
Q7	A. Optical clarity	15	10.9
Q7	B. High modulus, low stress relax.	77	55.8
Q7	C. Formability	15	10.9
Q7	D. Biodegradability	18	13.0
Q7	E. Spring back	13	9.4
Q8	A. Horizontal bevelled rect.	77	55.8
Q8	B. Ellipsoid passive	20	14.5
Q8	C. Vertical rectangular	11	8.0
Q8	D. Aligner only	20	14.5
Q8	E. Other	10	7.2
Q9	A. Bite ramps & intrusion	81	58.7
Q9	B. Hybrid with TADs	6	4.3
Q9	C. Posterior extrusion	20	14.5
Q9	D. Simultaneous intr.+extr.	17	12.3
Q9	E. Other	14	10.1
Q10	A. Posterior intrusion ramps	85	61.6
Q10	B. Anterior extrusion attach.	19	13.8
Q10	C. Extrusion + box elastics	9	6.5
Q10	D. Ant. extr.+Post. intr.	15	10.9
Q10	E. Other	10	7.2
Q11	A. Buccal expansion software	10	7.2
Q11	B. Cross elastics/buttons	88	63.8
Q11	C. RME+aligners	17	12.3
Q11	D. SME+aligners	12	8.7
Q11	E. Other	11	8.0
Q12	A. Exp+derot→Vert→Sag→Torque	75	54.3
Q12	B. Vert→Exp→Sag→Torque	13	9.4

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Q12	C. Sag→Torque→Exp→Vert	17	12.3
Q12	D. Torque→Exp→Vert→Sag	14	10.1
Q12	E. Other	19	13.8
Q13	A. Attachment mismatch	18	13.0
Q13	B. Short crowns	15	10.9
Q13	C. Complex staging	15	10.9
Q13	D. Distortion thermoforming	10	7.2
Q13	E. Poor compliance	80	58.0
Q14	A. Soft tissue injury	17	12.3
Q14	B. Material fatigue	13	9.4
Q14	C. Unpredictable tipping	79	57.2
Q14	D. Fenestration/dehiscence	12	8.7
Q14	E. Other	17	12.3
Q15	A. Scalloped supra	14	10.1
Q15	B. Scalloped equi	17	12.3
Q15	C. Straight supra	86	62.3
Q15	D. Straight equi	9	6.5
Q15	E. Other	12	8.7
Q16	A. IPR	15	10.9
Q16	B. Extractions	10	7.2
Q16	C. Expansion	15	10.9
Q16	D. IPR+Expansion	80	58.0
Q16	E. Ext+Expansion	18	13.0
Q17	A. Staging planning	85	61.6
Q17	B. Attachment planning	14	10.1
Q17	C. Anchorage planning	11	8.0
Q17	D. Hybrid mechanics	14	10.1
Q17	E. Other	14	10.1
Q18	A. Control digital staging	13	9.4
Q18	B. Flexible refinements	9	6.5
Q18	C. Cost efficiency	88	63.8
Q18	D. Case-specific attachments	16	11.6
Q18	E. Other	12	8.7
Q19	A. Limited AI biomechanics	12	8.7
Q19	B. Lack proprietary material	15	10.9

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Q19	C. Reduced predictability	80	58.0
Q19	D. Reciprocal movements	17	12.3
Q19	E. Other	14	10.1

Table no 2: Descriptive Statistics of Responses to the Questionnaire by Post Graduate Students

Question	Option	Frequency (PG Students)	Percentage (PG Students)
Q1	A. 2°	95	68.8
Q1	B. 1°	15	10.9
Q1	C. 3°	12	8.7
Q1	D. 1.5°	16	11.6
Q2	A. Vertical rect. occl. bevel	83	60.1
Q2	B. Horizontal rect. occl. bevel	11	8.0
Q2	C. Vertical rect. ging. bevel	10	7.2
Q2	D. Horizontal rect. ging. bevel	19	13.8
Q2	E. Other	15	10.9
Q3	A. 2mm ging.	14	10.1
Q3	B. Middle crown	87	63.0
Q3	C. 2mm occl.	9	6.5
Q3	D. 1mm ging.	14	10.1
Q3	E. Other	14	10.1
Q4	A. Rectangular attachments	11	8.0
Q4	B. Ellipsoid gingival	15	10.9
Q4	C. Power ridges	81	58.7
Q4	D. 5° torque PETG	11	8.0
Q4	E. Other	20	14.5
Q5	A. Sequential distalization	92	66.7
Q5	B. En-masse distalization	11	8.0
Q5	C. Extractions	12	8.7
Q5	D. Mand. Adv/Max. Setback	18	13.0
Q5	E. Other	5	3.6
Q6	A. Sequential mesialization	86	62.3
Q6	B. En-masse mesialization	11	8.0
Q6	C. Extractions	17	12.3
Q6	D. Max. Adv/Mand. Setback	11	8.0

Q6	E. Other	13	9.4
Q7	A. Optical clarity	18	13.0
Q7	B. High modulus, low stress relax.	81	58.7
Q7	C. Formability	15	10.9
Q7	D. Biodegradability	11	8.0
Q7	E. Spring back	13	9.4
Q8	A. Horizontal bevelled rect.	85	61.6
Q8	B. Ellipsoid passive	14	10.1
Q8	C. Vertical rectangular	15	10.9
Q8	D. Aligner only	15	10.9
Q8	E. Other	9	6.5
Q9	A. Bite ramps & intrusion	84	60.9
Q9	B. Hybrid with TADs	11	8.0
Q9	C. Posterior extrusion	18	13.0
Q9	D. Simultaneous intr.+extr.	9	6.5
Q9	E. Other	16	11.6
Q10	A. Posterior intrusion ramps	83	60.1
Q10	B. Anterior extrusion attach.	12	8.7
Q10	C. Extrusion + box elastics	14	10.1
Q10	D. Ant. extr.+Post. intr.	15	10.9
Q10	E. Other	14	10.1
Q11	A. Buccal expansion software	12	8.7
Q11	B. Cross elastics/buttons	88	63.8
Q11	C. RME+aligners	15	10.9
Q11	D. SME+aligners	13	9.4
Q11	E. Other	10	7.2
Q12	A. Exp+derot→Vert→Sag→Torque	76	55.1
Q12	B. Vert→Exp→Sag→Torque	15	10.9
Q12	C. Sag→Torque→Exp→Vert	21	15.2
Q12	D. Torque→Exp→Vert→Sag	15	10.9
Q12	E. Other	11	8.0
Q13	A. Attachment mismatch	12	8.7
Q13	B. Short crowns	13	9.4
Q13	C. Complex staging	17	12.3
Q13	D. Distortion thermoforming	15	10.9

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Q13	E. Poor compliance	81	58.7
Q14	A. Soft tissue injury	16	11.6
Q14	B. Material fatigue	12	8.7
Q14	C. Unpredictable tipping	86	62.3
Q14	D. Fenestration/dehiscence	14	10.1
Q14	E. Other	10	7.2
Q15	A. Scalloped supra	13	9.4
Q15	B. Scalloped equi	14	10.1
Q15	C. Straight supra	85	61.6
Q15	D. Straight equi	18	13.0
Q15	E. Other	8	5.8
Q16	A. IPR	12	8.7
Q16	B. Extractions	23	16.7
Q16	C. Expansion	11	8.0
Q16	D. IPR+Expansion	74	53.6
Q16	E. Ext+Expansion	18	13.0
Q17	A. Staging planning	78	56.5
Q17	B. Attachment planning	18	13.0
Q17	C. Anchorage planning	15	10.9
Q17	D. Hybrid mechanics	13	9.4
Q17	E. Other	14	10.1
Q18	A. Control digital staging	14	10.1
Q18	B. Flexible refinements	9	6.5
Q18	C. Cost efficiency	89	64.5
Q18	D. Case-specific attachments	15	10.9
Q18	E. Other	11	8.0
Q19	A. Limited AI biomechanics	17	12.3
Q19	B. Lack proprietary material	16	11.6
Q19	C. Reduced predictability	82	59.4
Q19	D. Reciprocal movements	11	8.0
Q19	E. Other	12	8.7

Knowledge of Biomechanics

Most participants correctly identified the ideal degree of rotation programmed per aligner as 2°, with similar responses from orthodontists (68.1%) and PG students (68.8%). For aligner retention, the majority in both groups preferred the vertical rectangular attachment with an occlusal bevel (Orthodontists: 60.1%, PGs: 60.1%). When asked about the optimal attachment position, more than half of orthodontists (50.7%) and nearly two-thirds of PG students (63.0%) selected the middle of the clinical crown. For torque planning of upper incisors, power ridges were the most frequently chosen option (Orthodontists: 60.9%, PGs: 58.7%).

Management of Malocclusions

For Angle's Class II Division 1 malocclusion, the preferred approach was sequential distalization of the upper arch (Orthodontists: 61.6%, PGs: 66.7%). Similarly, for Class III malocclusion, most respondents opted for sequential mesialization of the upper arch (Orthodontists: 60.9%, PGs: 62.3%).

In deep bite correction, the most common strategy was the use of anterior bite ramps with gradual incisor intrusion (Orthodontists: 58.7%, PGs: 60.9%). For open bite correction, posterior intrusion ramps were most frequently selected (Orthodontists: 61.6%, PGs: 60.1%). Regarding posterior crossbite management, the majority in both groups preferred the use of cross elastics with buttons/precision cuts (63.8% each).

Material Properties and Attachments

When asked about critical aligner material properties, both groups prioritized a high modulus of elasticity with low stress relaxation (Orthodontists: 55.8%, PGs: 58.7%). For extruding lateral incisors, the most favored attachment design was the horizontal bevelled rectangular attachment (Orthodontists: 55.8%, PGs: 61.6%).

Staging and Planning

The majority of respondents selected the sequence Expansion and derotation → Vertical control → Sagittal correction → Torque and root control → Finishing as the most effective staging approach (Orthodontists: 54.3%, PGs: 55.1%). The most difficult step identified in in-house aligner planning was staging of sequential tooth movements, as reported by 61.6% of orthodontists and 56.5% of PG students.

Challenges and Limitations

Poor patient compliance was considered the leading cause of aligner tracking loss (Orthodontists: 58.0%, PGs: 58.7%). In terms of limitations during buccal expansion (>4 mm), the majority highlighted unpredictable crown tipping without significant root control (Orthodontists: 57.2%, PGs: 62.3%).

Aligner Design Preferences

Most participants favored a straight supragingival aligner margin design (Orthodontists: 62.3%, PGs: 61.6%). For planning severe crowding cases, the majority of orthodontists (58.0%) and PG students (53.6%) preferred a combined approach of interproximal reduction (IPR) and expansion.

Attitude toward In-House Clear Aligners

The most valued advantage of in-house aligners was identified as cost efficiency and independence from third-party laboratories (Orthodontists: 63.8%, PGs: 64.5%). The most reported disadvantage was reduced predictability of complex tooth movements (Orthodontists: 58.0%, PGs: 59.4%).

4. Discussion

The present study aimed to evaluate and compare the knowledge and attitudes of orthodontists and postgraduate (PG) students in Gujarat regarding in-house clear aligner treatment planning. Both study groups comprised equal sample sizes (n = 138 each), ensuring balanced representation.

In the present study, both orthodontists and PG students demonstrated a good level of baseline knowledge regarding aligner biomechanics. A majority correctly identified the ideal degree of rotation per aligner as 2° (Orthodontists: 68.1%, PGs: 68.8%), which is in agreement with the findings of Mehta et al. (2021)[4] who emphasized the importance of limiting per-aligner tooth movement to optimize predictability. Similarly, vertical rectangular attachments with occlusal bevel were preferred by both groups (60.1% each), supporting existing literature that highlights their superior retention and biomechanical efficiency (Shilpa Chawla et al., 2023)[5].

Regarding attachment positioning, most PG students (63.0%) and half of orthodontists (50.7%) selected the middle of the crown, aligning with evidence that such placement provides optimal force transfer. Power ridges were also widely recognized as an effective strategy for torque planning, consistent with findings reported by Tamer et al. (2019)[2] who stressed their role in achieving controlled incisor movements.

With respect to malocclusion management, sequential distalization was the most commonly chosen approach for Class II correction (Orthodontists: 61.6%, PGs: 66.7%), while sequential mesialization was preferred for Class III correction (Orthodontists: 60.9%, PGs: 62.3%). These responses reflect awareness of clinically accepted biomechanics for sagittal correction with aligners. Similar strategies were noted by Meade et al. (2023)[7], who reported that distalization protocols remain central to aligner therapy for Class II patients.

In the management of vertical discrepancies, anterior bite ramps with incisor intrusion were favored for deep bite correction, while posterior intrusion ramps were preferred

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for open bite cases. These findings are consistent with the work of Basu et al. (2024)[8], who demonstrated that auxiliary features such as bite ramps improve treatment predictability in vertical corrections. For posterior crossbite correction, both groups predominantly relied on cross elastics with precision cuts (63.8%), in line with the recommendations of Kundal and Shokeen (2020)[3].

The present study also highlighted participants' awareness of material properties, as the majority selected high modulus with low stress relaxation as the most critical factor for long-term performance. This finding is comparable with previous reports that stress the importance of elastic modulus in maintaining continuous force application (Kulkarni et al., 2023)[6]. Similarly, horizontal bevelled rectangular attachments were considered the most effective for extrusion of lateral incisors, supporting clinical reports that emphasize their role in achieving controlled vertical movements.

In terms of treatment staging, the sequence "Expansion and derotation → Vertical control → Sagittal correction → Torque and root control" was most commonly preferred by both orthodontists and PG students. This sequential planning reflects biomechanical logic and is supported by previous recommendations (Mehta et al., 2021)[4]. Notably, staging of sequential tooth movements was identified as the most difficult aspect of in-house aligner planning (Orthodontists: 61.6%, PGs: 56.5%). This mirrors findings by Meade and Weir (2023)[7], who observed that clinicians often require multiple refinements due to complexity in staging.

The most commonly reported cause of aligner tracking loss was poor patient compliance (Orthodontists: 58.0%, PGs: 58.7%), which remains a universal challenge in aligner therapy, as also highlighted in international surveys (Meade et al., 2023)[7]. Regarding limitations of buccal expansion beyond 4 mm, unpredictable crown tipping without sufficient root control was most frequently noted, echoing concerns from prior studies about the biomechanical limits of aligners (Chawla et al., 2023)[5].

Participants showed a clear preference for straight supragingival margin designs (Orthodontists: 62.3%, PGs: 61.6%), reflecting a trend toward designs that enhance retention and patient comfort. For severe crowding cases, most respondents advocated a combined approach of interproximal reduction (IPR) and expansion. This approach is consistent with published evidence suggesting that controlled IPR combined with expansion improves outcomes while avoiding unnecessary extractions (Basu et al., 2024)[8].

When evaluating attitudes, both groups strongly favored cost efficiency and independence from third-party laboratories as the primary advantage of in-house aligners (Orthodontists: 63.8%, PGs: 64.5%). This finding is supported by recent literature noting the economic benefits of in-house systems (Kulkarni et al., 2023)[6]. However, reduced predictability of complex movements was identified as the main disadvantage (Orthodontists: 58.0%, PGs: 59.4%), which concurs with previous reports highlighting limitations of in-house software and material properties (Tamer et al., 2019)[2].

Taken together, the findings of the present study indicate that both orthodontists and PG students possess sound theoretical knowledge of in-house clear aligner biomechanics and planning, though concerns about staging complexity and movement predictability remain. These results underscore the need for targeted training, particularly in digital staging and biomechanical planning, to enhance clinical confidence and optimize outcomes in in-house aligner therapy.

5. Conclusion

The present study evaluated the knowledge and attitudes of orthodontists and postgraduate students in Gujarat regarding in-house clear aligner treatment planning. Both groups demonstrated a good understanding of aligner biomechanics, staging, and material properties, with similar response patterns across most domains. Sequential distalization for Class II, mesialization for Class III, bite ramps for deep bite correction, and posterior intrusion ramps for open bite correction were consistently identified as preferred strategies.

Cost efficiency and clinical independence were recognized as the major advantages of in-house aligners, while reduced predictability of complex movements and staging difficulties were regarded as the main limitations. Patient compliance and the risk of uncontrolled tipping during expansion were also highlighted as significant clinical challenges.

Overall, the findings indicate that both orthodontists and postgraduate students possess sound theoretical knowledge and favorable attitudes toward in-house aligner systems. However, the concerns expressed emphasize the need for further training in digital staging, biomechanics, and refinement protocols to enhance predictability and clinical outcomes. Strengthening these competencies may improve the adoption and efficiency of in-house clear aligner therapy in both academic and clinical settings.

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