Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

Evaluation of Knowledge, Attitude & Practice of Various Types of Attachment Design Used in Aligners among Postgraduate Students of Orthodontics All Over India – A Questionnaire Study

Dr.Santosh Kumar Goje[1], Dr.Prishita Mehta[2], Dr.Anjali Ganatra[3], Dr.Yashraj Kharade[4], Dr. Nancy Agrawal[5]

[1]HOD & Professor, Department of Orthodontics & Dentofacial Orthopedics,KM Shah Dental College & Hospital/ Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India.

[2,3,4,5]Post Graduate, Department of Orthodontics & Dentofacial Orthopedics,KM Shah Dental College & Hospital/ Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India.

(Received: 15 September 2025 Revised: 22 October2025 Accepted: 30 November2025)

KEYWORDS

Clear Aligners, Orthodontics, Attachments, Biomechanics, Postgraduate Education, Questionnaire

ABSTRACT:

Introduction: Clear aligners have transformed orthodontic treatment with their aesthetic appeal and patient comfort. However, the efficacy of aligners is largely influenced by the type, position, and design of attachments used. Understanding how postgraduate orthodontic students apply and perceive these variables is critical for ensuring optimal clinical outcomes. Aim: To assess the knowledge, attitude, and practice (KAP) regarding various attachment designs used in aligner therapy among IOS-registered third-year postgraduate students of Orthodontics across India. Methodology: A cross-sectional questionnaire-based study was conducted at the Department of Orthodontics and Dentofacial Orthopaedics, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth. The pre-validated and reliability-tested questionnaire was distributed via WhatsApp to all IOS-registered third-year postgraduate students (n=1900), as per the Indian Orthodontic Society directory (2023). A minimum sample size of 320 was estimated using standard formulae at a 95% confidence level. Responses were collected over four weeks, with reminders sent weekly. Content validity, construct validity, and internal consistency (Cronbach's $\alpha = 0.8$) were ensured. Data were subjected to descriptive and inferential statistical analysis. Results: The response rate was adequate, and most participants demonstrated fair knowledge and positive attitudes regarding aligner attachments. While vertical rectangular occlusally beveled attachments were favoured for retention, many also recognized the importance of attachment positioning, overcorrection, and controlled staging. However, gaps in preference were noted in aspects like torque control, extrusion strategies, and optimal material choices. Conclusion: Although third-year postgraduate orthodontic students possess a foundational understanding of aligner attachment designs, the study highlights areas requiring further training and evidence-based reinforcement. Incorporating aligner-specific biomechanics and attachment protocols into the postgraduate curriculum is recommended to enhance clinical efficacy and aligner treatment predictability.

1. Introduction

Clear aligner therapy (CAT) has transformed the orthodontic landscape since its introduction in the late 1990s. Initially marketed as an esthetic option for minor crowding, aligners are now applied to treat increasingly complex malocclusions, including deep bites, posterior crossbites, and extraction cases [1,2]. Patients are attracted to their transparency, removability, and comfort, while clinicians appreciate their facilitation of oral hygiene and reduction in emergency visits [3]. Despite these benefits, a recurring concern with aligners is their variable predictability of tooth movement compared with fixed appliances [4].

Among the strategies developed to improve aligner efficacy, attachments occupy a central role. Attachments are composite shapes bonded to the tooth surface, intended not to generate force but to enhance aligner grip, redirect force vectors, and improve force

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

transmission [5]. By increasing the surface area of engagement, attachments enable aligners to exert complex forces that would otherwise be biomechanically inefficient. For example, gingivally beveled attachments assist with extrusion, while occlusally beveled attachments favor intrusion [6,7].

However, unlike orthodontic brackets, which are standardized, attachment design is not uniform across aligner systems. Conventional attachments (rectangular, ellipsoid) coexist with optimized, software-generated designs tailored for specific tooth movements [8,9]. Optimized attachments have demonstrated improved clinical outcomes, such as better derotation of premolars and extrusion of anterior teeth [8]. Yet even with these advances, certain movements remain less predictable—extrusion and root torque in particular [1,10,11].

Clinical predictability is directly linked to clinician knowledge. Studies consistently show that extrusion predictability can be as low as 29% [1], while torque expression lags behind fixed appliances [11]. These limitations mean orthodontists must use attachments judiciously and integrate them with overcorrection strategies [12]. Without adequate training, misapplication of attachments can lead to inefficiencies, refinements, and patient dissatisfaction [13].

Despite the rising adoption of aligners in India, postgraduate orthodontic education in this area is inconsistent. Selvaraj et al. [14] found that many Indian interns lacked awareness of aligner biomechanics, while Bhosale et al. [5] reported variability in practitioner confidence regarding attachment use. Internationally, similar concerns persist. Rehil et al. [15] noted that over half of U.S. orthodontic residents reported insufficient aligner instruction, while Pelsmaekers et al. [16] identified similar gaps in European curricula.

Given the rapid rise in patient demand for aligners, orthodontic postgraduate training must adapt to ensure graduates are not only theoretically sound but also clinically confident in aligner biomechanics. Third-year students, nearing the end of their training, are uniquely positioned to reflect both academic learning and early clinical exposure as they are the very group who are expected to graduate into clinical practice with competence in aligner therapy. Attachments, being the cornerstone of aligner predictability, deserve specific focus.

However, a thorough literature search revealed no prior study evaluating the KAP of third-year postgraduate students in India specifically regarding attachment design in aligners. This absence of evidence forms the rationale for the present study.

By systematically evaluating postgraduate students' understanding of attachment designs, placement protocols, material preferences, and staging strategies, this research aims to assess postgraduate students' competence in attachment design knowledge, attitudes toward their use, and actual clinical practices.

2. Materials and Methods

Study Design

This research was designed as a cross-sectional, questionnaire-based survey. Cross-sectional studies are widely used in healthcare education and behavioral sciences to assess the knowledge, attitude, and practices (KAP) of a defined population at a single point in time. In the context of orthodontics, such designs are particularly useful because they allow researchers to capture the perceptions of large groups of students or clinicians regarding rapidly evolving technologies such as clear aligner therapy.

Ethical Approval

Prior to commencement, the study protocol was submitted to the Sumandeep Vidyapeeth Institutional Ethics Committee (SVIEC) for approval. Data collection occurred within the first month of initiation, with subsequent time allocated to validation, reminders, and analysis.

Place of Study

The study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, K. M. Shah Dental College and Hospital, Sumandeep Vidyapeeth, Piparia, Vadodara, India. While the administrative base was localized, the scope extended nationally, as participants were enrolled from across India through electronic communication (Whatsapp).

Target Population

The target population consisted of Indian Orthodontic Society (IOS)-registered third-year postgraduate students in Orthodontics and Dentofacial Orthopedics. This group was chosen deliberately because:

1. They represent advanced learners nearing completion of their training.
2. Their responses reflect cumulative academic exposure and early clinical experiences.
3. They are expected to soon practice independently, making their knowledge and attitudes directly relevant to future orthodontic care delivery.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

Inclusion Criteria

- IOS-registered third-year postgraduate students of Orthodontics and Dentofacial Orthopedics.
- Students with access to WhatsApp, the medium used for questionnaire distribution.

Exclusion Criteria

- Third-year postgraduate students not using WhatsApp.
- Students unwilling to provide informed consent.

Population and Sampling

All 1900 IOS-registered third-year postgraduate orthodontic students in India were invited. Using Cochran's formula with a confidence level of 95% and margin of error of 5%, a minimum of 320 responses were deemed sufficient.

Questionnaire Development

The questionnaire included:

- **Section 1:** Demographics (gender).
- **Section 2:** Knowledge (e.g., attachment biomechanics, extrusion/intrusion strategies).
- **Section 3:** Attitude (e.g., preference for optimized vs conventional attachments, overcorrection necessity).
- **Section 4:** Practice (e.g., composite choice, staging strategies).

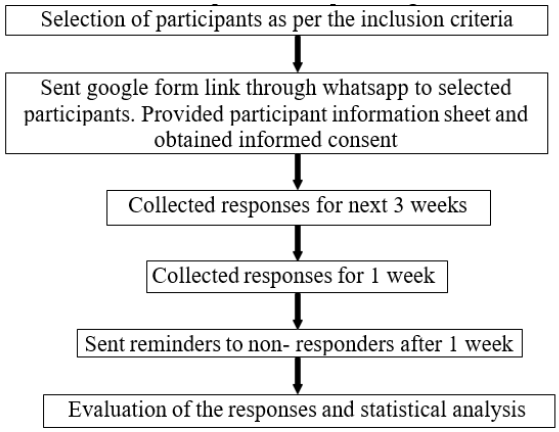
Validation involved content review by five orthodontic experts, achieving a Content Validity Index (CVI) of 0.89. Pilot testing with 30 students yielded Cronbach's alpha = 0.82, indicating internal consistency.

3. Methodology

The participants were selected according to the inclusion criteria and the questionnaire was sent to all the selected 3rd year IOS registered post graduate students of Orthodontics & Dentofacial Orthopedics via google form link through WhatsApp message. Their numbers were obtained from Indian Orthodontic Society Directory updated till 2023. All the participants were informed about the study and Informed consent was obtained. Those participants who consented to participate had fill the questionnaire and submitted it. Non responding participants were reminded after a week and responses were collected for another 3 weeks. The responses received after 4 weeks were not included in the study. The all obtained responses were further subjected to statistical analysis to conclude the results.

Statistical Analysis

Descriptive statistics summarized frequencies and percentages.



Questionnaire

1. Which type of attachment provides better retention in aligners
   A. Vertical rectangular occlusally beveled
   B. Horizontal rectangular occlusally beveled
   C. Vertical rectangular gingivally beveled
   D. Horizontal rectangular gingivally beveled

2. Which aligner attachment position sequence provides better retention except for horizontal type of attachments
   [2mm from gingival margin (1), center of crown (2), 2mm occlusal(3)]
   A. 1>2>3
   B. 2>1>3
   C. 3>2>1

3. Which aligner attachment position sequence provides better retention for horizontal type of attachments [2mm from gingival margin [2mm from gingival margin (1), center of crown (2), 2mm occlusal(3)]
   A. 1>2>3
   B. 2>1>3
   C. 3>2>1

4. How does aligner Attachments carry tooth movement
   A. Active agents that produce force
   B. Passively get in way of plastic as it elastically deforms

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

C. Both A & Bare true
D. Both A & B are false

5. Which type of attachments provide more buccal tipping during Expansion
   A. Buccally placed attachments
   B. Lingually placed attachments
   C. Equal from both
   D. Cannot be achieved through aligners

6. Which type of attachments do u consider better for controlled tooth movement
   A. Conventional
   B. Optimised

7. Do u think overcorrection is required even with the use of attachments in aligners
   A. Yes
   B. No

8. Which type of attachment material provides greater dimensional stability:
   A. Low filled composite resin
   B. Bulk filled composite resin
   C. Same for both

9. Which of the following helps in determining the optimal attachment design
   A. Geometry
   B. Location
   C. Size
   D. All of above

10. What approximate amount of rotational movement do you incorporate per aligner with attachments to avoid loss of tracking
    A. 2°
    B. 1°
    C. 3°
    D. 1.5°

11. Which type of attachment do you use in practice for improved predictability of anterior Intrusion
    A. Gingival beveled
    B. Occlusal beveled
    C. No attachment
    D. Impossible with aligners

12. What approximate amount of intrusion/ extrusion movement do u choose per aligner with attachments to avoid loss of tracking
    A. 0.2mm
    B. 0.1mm
    C. 0.6mm
    D. 1.5mm

13. What kind of staging do u practice with attachments?
    A. Segmented Staging
    B. Simultaneous Staging

14. What approximate amount of root torque do you opt for per aligner with attachments to avoid loss of tracking
    A. 2°
    B. 1°
    C. 3°
    D. 1.5°

15. Which type of attachment do you use for improved predictability of anterior Extrusion
    A. Gingival beveled
    B. Occlusal beveled
    C. No attachment
    D. Impossible with aligners

4. Results

Sr. No.	Option 1	Option 2	Option 3	Option 3
Gender	33.3% Female	66.6% Male	-	-
1.	4.3	50	19	26.7
2.	53.3	26.7	20	-
3.	13.4	53.3	33.3	-
4.	20	45	28.7	6.3
5.	33.3	40	26.7	0
6.	80	20	-	-
7.	100	0	-	-
8.	26.7	63.3	10	-
9.	5	5	10	80
10.	26.7	6.7	26.6	40

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

11.	20	73.3	6.7	0
12.	53.3	13.3	13.3	20
13.	53.3	46.7	-	-
14.	33.3	53.3	6.7	6.7
15.	60	40	0	0

5. Discussion

The participants that is 3rd year post graduate students for aligner attachment questionnaire were 33.3% females ad 66.6% males

Type of attachment for retention in aligners, 50% participants chose horizontal rectangular occlusally beveled attachment whereas 4.3% post graduates chose vertical rectangular occlusally beveled, 19% chose Vertical rectangular gingivally beveled and 26.7% chose Horizontal rectangular gingivally beveled. These attachments increase the surface area and provide a better point of contact for the aligner plastic, particularly useful in resisting dislodgement during function. This is consistent with the findings of Dasya et al., who found beveled attachments to significantly improve aligner grip [7].

Aligner attachment position sequence which provides better retention except for horizontal type of attachments, maximum participants chose 2mm gingival then centre of crown and then 2mm occlusal. Proper vertical positioning is essential for optimized force transmission, as attachment placement close to the center of resistance improves force efficiency. [17]

For Horizontal attachments better retention sequence as chosen by most participants was Centre of crown, 2mm from gingival margin and 2mm from occlusal. A potential knowledge gap in understanding how position modifies the mechanical vector delivered by aligners may affect the treatment plan.

When asked about how does aligner attachments carry tooth movement, most of the participants (45%) chose that attachments passively get in way of plastic as it elastically deforms and 20 % chose Active agents that produce forces whereas 28.7% believe that it is possible because of both of the above reasons and 6.3% believes that there are other reasons for attachments to carry out tooth movements. According to Li et al[18]., attachments do not apply active forces themselves; rather, they act as mechanical couplers that improve aligner engagement and force direction [17]. This reflects moderate understanding of aligner biomechanics.

40% indicated lingually placed attachments are more effective in generating buccal tipping during expansion whereas 33% chose buccaly placed attachments and rest chose that it is equal for both. This is because forces applied from the lingual side are more effective in moving teeth buccally, especially during arch development or posterior expansion phases [18]

A strong 80% majority correctly preferred optimized attachments, which are generated by aligner software based on movement complexity. Optimized attachments consider tooth morphology, vector of force, and required movement, providing superior predictability, particularly in torque, root control, and rotation [8]. This high percentage reflects good theoretical understanding among postgraduates.

All participants (100%) agreed that overcorrection is necessary even with attachments. This reflects excellent clinical insight. Khosravi et al. and Simon et al. [8,12] both report that due to aligner flexibility and tracking loss, planned overcorrections help compensate for elastic limitations and ensure complete expression of the intended movement.

63.3% selected bulk-filled composite resins as the preferred material for dimensional stability. These materials maintain shape and resist wear under prolonged intraoral forces. According to Sheridan and clinical guidelines, bulk-filled resins are more suitable for attachments due to their higher filler content and resistance to deformation [17]. The remaining 26.7% selecting low-filled composites indicates some uncertainty that should be addressed in materials education.

A strong majority (80%) correctly selected all of the above (geometry, size, and location). Attachment design is not one-dimensional—its effectiveness depends on how well its shape, orientation, and position complement the intended tooth movement [17,8].

Answers were mixed, with 40% selecting 1.5°, 26.7% choosing 2°, and only 6.7% selecting 3°. Studies, including Simon et al. [8], suggest rotational movements greater than 2° per aligner increase the risk of tracking loss, especially for cylindrical teeth like premolars. This spread of responses indicates varying levels of clinical conservatism or confusion about safe thresholds for rotation in aligner staging.

A majority (73.3%) selected occlusal beveled attachments, which help in applying vertical intrusive forces closer to the center of resistance in anterior teeth. Literature shows these attachments enhance the predictability of vertical movements when programmed correctly [1,17]. A small percentage (6.7%) selected "no attachment", showing underestimation of attachment

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

importance in vertical control.

53.3% selected 0.2 mm, consistent with clinical protocols that suggest small incremental vertical movements to reduce the risk of tracking loss and patient discomfort [14]. Choosing larger values like 1.5 mm (selected by 20%) could compromise movement predictability, indicating a training need in aligner staging principles.

There was nearly split between segmented staging (53.3%) and simultaneous staging (46.7%). While segmented staging is often favored in complex cases to improve movement control, simultaneous staging can be effective when forces are balanced. This variation in responses reflects differences in clinical exposure and personal preferences, but both methods are clinically valid when used judiciously [5]. 53.3% selected 1°, a conservative and evidence-based choice for safe torque movement. Torque is notoriously difficult to achieve with aligners, even with attachments. Excessive torque per aligner (e.g., 3° or more) often leads to plastic deformation and tracking failure [4]. These findings reveal moderate understanding, with potential to improve awareness about the biomechanics of root movement.

60% correctly chose gingival beveled attachments, designed to enhance the plastic engagement necessary to pull a tooth downward [18]. 40% selected occlusal beveled, possibly due to confusion with intrusion mechanics. This again underscores the need for focused training in the direction-specific design of attachments

Overall, the study reflects a moderate to high level of awareness among third-year orthodontic postgraduate students regarding attachment biomechanics, material science, and clinical staging. Compared to general dental practitioners and interns in earlier studies by Selvaraj et al. [14] and Bhosale et al. [5], postgraduate students demonstrate greater conceptual clarity, likely owing to their advanced academic exposure. However, misconceptions in positioning sequences, movement staging limits, and torque thresholds highlight gaps between theory and practice.

This study did not evaluate the impact of institutional curriculum differences, hands-on aligner exposure, or case planning experience—factors that may influence knowledge and confidence. Also, self-reporting bias may exist, and further studies can incorporate objective assessments or clinical case simulations.

6. Conclusion

While the foundational knowledge of aligner attachment design among Indian orthodontic postgraduates is promising, the study reveals specific conceptual and biomechanical gaps that warrant curriculum enhancement. Structured teaching modules focusing on attachment mechanics, movement thresholds, and digital staging should be integrated into postgraduate programs to bridge the gap between academic knowledge and clinical expertise.

Human and Animal Rights

No human rights were violated in the present study.

Consent for Publication

Consent for publication was obtained by each patient, by the patients' parents and legal representatives.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise

Acknowledgements

Declared none.

7. References

1. Kravitz ND, Kusnoto B, Begole E, Obrez A, Agran B. How well does Invisalign work? Am J Orthod Dentofacial Orthop. 2009;135(1):27-35.
2. Papadimitriou A, Mousoulea S, Gkantidis N, Kloukos D. Clinical effectiveness of Invisalign® orthodontic treatment: a systematic review. Prog Orthod. 2018;19(1):37.
3. Phan X, Ling PH. Clinical limitations of Invisalign. J Can Dent Assoc. 2007;73(3):263-6.
4. Elkholy F, Pancherz H. The biomechanics of aligners. Semin Orthod. 2021;27(4):303-12.
5. Bhosale S, Kshirsagar P, Khadse A. Perception of aligner therapy among practitioners. Int J Orthod Rehabil. 2021;12(2):72-7.
6. Dasy H, Dasy A, Asatrian G, Rózsa N, Lee HF, Kwak JH. Effects of variable attachment designs on aligner retention. Angle Orthod. 2015;85(6):934-40.
7. Castroflorio T, Garino F, Lazzaro A, Debernardi C. Upper molar distalization with aligners in adult patients: a multicenter retrospective study. Prog Orthod. 2018;19(1):30
8. Simon M, Keilig L, Schwarze J, Jung BA, Bourauel C. Treatment outcome and efficacy of an aligner technique. BMC Oral Health. 2014;14:68

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 1738-1744 | ISSN: 2251-6719

9. Haouili N, Kravitz ND, Vaid NR, Ferguson DJ, Makki L. Has Invisalign improved? A prospective clinical study on efficacy. Angle Orthod. 2020;90(2):138-45.

10. Chisari JR, McGorray SP, Nair M, Wheeler TT. Variables affecting orthodontic tooth movement with aligners: extrusion predictability. Angle Orthod. 2020;90(1):23-9.

11. Lombardo L, Arreghini A, Ramina F, Huanca Ghislanzoni LT, Siciliani G. Predictability of torque with aligners vs fixed appliances. Angle Orthod. 2020;90(5):658-65.

12. Khosravi R, Cohanim B, Hujoel P, Daher S, Neal M, Liu W, et al. Management of overbite with Invisalign. Am J Orthod Dentofacial Orthop. 2017;151(4):691-9.

13. Gay G, Ravera S, Castroflorio T. Root control with aligners: clinical challenges. Prog Orthod. 2019;20(1):21.

14. Selvaraj A, Ganesh A, Krishnan R. Awareness of clear aligner therapy among interns. J Contemp Dent Pract. 2020;21(5):543-7.

15. Rehil S, Andrews L, Kuo CL, Little RM, Huang GJ. Residents' knowledge about clear aligners. Angle Orthod. 2022;92(1):84-91.

16. Pelsmaekers B, Cuypers V, Verdonck A, Carels C, Dermaut L. Orthodontic education in Europe: a survey of postgraduate programs. Eur J Orthod. 2002;24(5):623-35.

17. Rehil S, Subramani K, Sinha P, Jain S, Roberson G, Chattopadhyay A. Education using clear aligners and digital workflows in graduate orthodontic residency programs. Semin Orthod . 2022;28(2):80–4

18. Sejani V, Kubavat AK, Patel KV, Patel R, Patel A, Bhavsar P. A questionnaire-based survey of postgraduate students on awareness about direct printed aligners. J Pharm Bioallied Sci. 2024;16(3): 2018–20.