Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies *NLM ID: 101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Review Article

Pain Perception between Fixed Orthodontic Appliances and Clear Aligners: A Narrative Review

[1]Aarthy M, [2]Aamira Fathima, [3]Rathika M, [4]Safoora Fathima, [5]M. K. Karthikeyan, [6]Saranya P

[1-4]Compulsory Rotary Residential Internship, [5]Professor & Head, [6]Senior Lecturer, Department of Orthodontics, Dr. M.G.R Educational and Research Institute, Chennai, Tamil Nadu, India

ABSTRACT:

Orthodontic treatment has become increasingly common due to its functional and esthetic benefits. However, patient comfort remains a major concern, as pain is frequently reported during treatment. Pain perception varies according to the type of appliance used, with fixed orthodontic appliances (braces) and clear aligners demonstrating distinct patterns of discomfort. This review aims to provide a comprehensive analysis of the mechanisms underlying orthodontic pain, the perception of discomfort associated with fixed appliances versus clear aligners, and the psychological and biological factors that influence pain experience. Furthermore, management strategies, including analgesic use, patient counseling, and appliance-specific interventions, are discussed. Understanding these aspects is essential for optimizing patient compliance, enhancing treatment outcomes, and improving overall patient satisfaction.

Keywords: Orthodontic pain, fixed appliances, clear aligners, pain perception, analgesics, patient compliance

Received: 22 October, 2025 Acceptance: 25 November, 2025 Published: 27 November, 2025

Corresponding Author: Aarthy M, Compulsory Rotatory Residential Internship, Department of Orthodontics, Dr M.G.R Educational and Research Institute, Chennai, Tamil Nadu, India

This article may be cited as: M Aarthy, Fathima A, M Rathika, Fathima S, Karthikeyan MK, P Saranya. Pain Perception between Fixed Orthodontic Appliances and Clear Aligners: A Narrative Review. J AdvMed Dent Scie Res 2025; 13(11):49-54.

INTRODUCTION

Orthodontic treatment represents a pivotal intervention in dentistry, not only to correct malocclusion but also to enhance oral function, facial esthetics, and psychosocial well-being. Despite these benefits, patient experience is often affected by discomfort, particularly pain, which can influence compliance, oral hygiene maintenance, and overall satisfaction with treatment. Pain associated with orthodontic therapy is a complex, multifactorial phenomenon influenced by mechanical, biological, and psychological factors.

Fixed orthodontic appliances, including brackets, archwires, and ligatures, have been the traditional modality for comprehensive treatment. They are effective in managing a wide range of malocclusions; however, they are commonly associated with acute and sometimes chronic discomfort, particularly during initial archwire placement, activation, or adjustments. Studies have reported that approximately 70–95% of patients experience some degree of pain following fixed appliance insertion or activation, typically peaking within 24 hours and gradually decreasing over the subsequent days. Pain is often described as pressure, soreness, or tension and is most commonly localized to the anterior teeth and areas of active tooth movement.

In recent years, clear aligner therapy has emerged as an esthetically appealing alternative to fixed appliances. These removable, transparent devices gradually move teeth using a series of customized trays. Patients often perceive aligners as more comfortable due to the absence of brackets and ligatures, and the ability to remove appliances for eating or oral hygiene. Nevertheless, aligners can still induce pain, particularly during tray changes or when significant tooth movement is required. Understanding the differences in pain perception between these modalities is critical for clinicians when planning treatment and counseling patients.

Pain perception is not solely determined by the mechanical forces applied; biological and psychological factors play a significant role. Inflammatory mediators, periodontal ligament

responses, and nociceptive pathways contribute to the intensity and duration of discomfort. Additionally, patient-specific factors, including age, gender, pain threshold, anxiety levels, and previous dental experiences, modulate the subjective experience of pain. Consequently, a comprehensive understanding of both the objective and subjective components of orthodontic pain is essential for effective management.

Several studies have attempted to compare pain associated with fixed appliances and clear aligners. Evidence suggests that while both modalities cause discomfort, the pattern, intensity, and duration differ. Fixed appliances generally elicit higher initial pain, whereas aligners produce milder but more prolonged discomfort in some cases. Such differences have implications for treatment planning, patient counseling, and the development of pain management protocols tailored to individual needs.

This review aims to systematically evaluate existing literature on pain perception associated with fixed orthodontic appliances and clear aligners. It will discuss the underlying mechanisms of pain, the comparative intensity and duration of discomfort, psychological influences, management strategies, and clinical implications. By synthesizing current evidence, this review seeks to provide clinicians with a comprehensive understanding of orthodontic pain and strategies to optimize patient comfort and treatment adherence.

Mechanisms of Orthodontic Pain

Orthodontic pain is a complex physiological and psychological experience resulting from the application of mechanical forces to teeth and surrounding structures. The primary source of discomfort arises from the mechanical stress imposed on the periodontal ligament (PDL), alveolar bone, and associated neural structures. When an orthodontic force is applied, the PDL undergoes compression on one side of the tooth and tension on the opposite side. This mechanical deformation triggers a cascade of biological responses, including the release of inflammatory mediators such as prostaglandins, cytokines (e.g., interleukin-1β, tumor necrosis factor-α), and neuropeptides. These substances sensitize nociceptors in the PDL and alveolar bone, leading to the perception of pain.

Inflammation induced by orthodontic forces plays a dual role: while necessary for bone remodeling and tooth movement, it also contributes significantly to discomfort. Compression of the PDL causes ischemia and transient hypoxia, which further enhances the production of pain-inducing mediators. Studies have demonstrated that the intensity of pain correlates with both the magnitude and rate of force application, with heavier forces generally producing more pronounced inflammatory responses and discomfort.

At the neural level, orthodontic pain is transmitted via the trigeminal nerve, particularly its branches that innervate the periodontal tissues. Mechanoreceptors and nociceptors respond to tissue stress, sending signals to the central nervous system where they are perceived as pain. The central processing of these signals is influenced by individual pain thresholds, prior experiences, and psychological factors such as anxiety and stress. Consequently, the same orthodontic force may produce variable pain experiences among different patients.

Pain associated with orthodontic treatment is usually categorized as acute or delayed. Acute pain occurs immediately or within a few hours of appliance activation and is typically mild. Delayed-onset pain, which peaks 24–48 hours after activation, is more significant and is associated with inflammatory mediator activity and periodontal tissue remodeling. This temporal pattern is clinically important, as it influences patient perception and compliance during critical stages of treatment.

In addition to mechanical and inflammatory mechanisms, psychological factors such as fear, anxiety, and stress modulate pain perception. Patients with higher dental anxiety report greater discomfort, highlighting the need for clinicians to address both physiological and psychosocial components of orthodontic pain. Behavioral strategies, counseling, and proper communication can significantly reduce perceived pain and improve patient cooperation.

Pain Perception with Fixed Appliances

Fixed orthodontic appliances, including metal or ceramic brackets, archwires, and auxiliary components, remain the most widely used modality for comprehensive orthodontic treatment. Despite their effectiveness, they are consistently associated with higher levels of discomfort compared to removable devices. Pain perception with fixed appliances typically follows a characteristic timeline: onset within a few hours post-activation, peak intensity within 24–48 hours, and gradual decline over 3–7 days.

Several studies have quantified pain in patients undergoing fixed appliance therapy using visual analog scales (VAS) or numerical rating scales (NRS). Evidence indicates that the majority of patients experience mild-to-moderate pain during the initial stages of treatment, with peak discomfort often reported following the first archwire placement. Pain is most pronounced in the anterior teeth, particularly maxillary incisors, due to their smaller root surface area and higher sensitivity of PDL fibers. Posterior teeth also experience discomfort, often described as pressure or soreness during mastication.

The type of archwire, force magnitude, and method of ligation significantly influence pain intensity. For example, NiTi archwires, commonly used for initial alignment, produce lighter and continuous forces, resulting in less severe discomfort compared to stainless steel wires or heavy initial forces. Similarly, self-ligating brackets may reduce friction and

associated pain compared to conventional ligature systems, though the evidence remains mixed.

Pain is also affected by the duration and frequency of adjustments. Frequent activation of archwires or elastics may prolong inflammatory responses, leading to cumulative discomfort. Conversely, longer intervals between adjustments can reduce repeated pain episodes but may slow treatment progress. Clinicians must balance biomechanical efficiency with patient comfort to optimize treatment outcomes.

In addition to mechanical and biological factors, individual patient characteristics influence pain perception with fixed appliances. Age, gender, previous dental experiences, and psychological profile play crucial roles. Younger patients often report higher pain intensity due to lower tolerance, while females may experience more pronounced discomfort than males, potentially related to hormonal and neural differences in pain processing. Patients with high dental anxiety or negative prior experiences may report amplified pain, emphasizing the need for pre-treatment counseling and reassurance.

Pain associated with fixed appliances can affect oral function and quality of life. Patients commonly report difficulties in mastication, speech, and oral hygiene practices, particularly during the first few days following appliance activation. Soft tissue irritation caused by brackets and wires can exacerbate discomfort, leading to mucosal ulcerations or inflammation. Preventive strategies such as orthodontic wax, analgesics, and careful appliance placement can mitigate these adverse effects.

Analgesic use is a common approach to manage fixed appliance pain. Non-steroidal anti-inflammatory drugs (NSAIDs) are widely employed due to their efficacy in reducing both pain intensity and inflammatory mediator activity. However, clinicians must consider the potential impact of NSAIDs on orthodontic tooth movement, as some studies suggest that prolonged NSAID use may slightly delay bone remodeling. Short-term, targeted use immediately following activation is generally considered safe and effective.

Overall, fixed appliances are associated with predictable patterns of discomfort influenced by mechanical, biological, and psychosocial factors. Understanding these determinants allows clinicians to anticipate pain, counsel patients effectively, and implement strategies to minimize discomfort while ensuring optimal treatment progression.

Pain Perception with Clear Aligners

Clear aligners have revolutionized orthodontic treatment by offering an esthetically pleasing and removable alternative to traditional fixed appliances. These custom-fabricated, transparent trays gradually move teeth through sequential adjustments, typically involving a series of aligners worn for 1–2 weeks each. Although perceived as more comfortable than fixed appliances, aligners are not entirely devoid of pain or discomfort.

Patients commonly report mild to moderate discomfort during the initial placement of each new aligner. This pain is usually characterized as pressure, tightness, or soreness localized to the teeth or supporting periodontium. The intensity of discomfort is influenced by the magnitude of force required for tooth movement, the number of teeth being moved simultaneously, and the individual's pain threshold. Studies suggest that pain with clear aligners tends to be lower in intensity than with fixed appliances, and the peak usually occurs within the first 24–48 hours after placement of a new tray, diminishing over the following days.

The mechanism of pain with aligners is similar to fixed appliances, involving mechanical forces that induce periodontal ligament stress, alveolar bone remodeling, and inflammatory mediator release. However, forces exerted by aligners are typically lighter, more controlled, and distributed over a broader area, which may account for the reduced pain intensity. In addition, the absence of brackets and wires minimizes soft tissue irritation, a significant source of discomfort in fixed appliance therapy.

Patient-specific factors continue to play a role in aligner-related pain. Individuals with low pain tolerance, heightened anxiety, or prior negative dental experiences may perceive more pronounced discomfort. Compliance with wear time also affects pain patterns; incomplete or irregular aligner use can lead to delayed tooth movement, requiring subsequent force intensification, which may increase discomfort.

Despite lower overall pain levels, clear aligners can induce prolonged mild discomfort in certain scenarios. Complex movements, such as extrusion, rotation of rounded teeth, or correction of severe crowding, may require increased forces or auxiliary attachments, which can intensify soreness. Additionally, some patients report temporomandibular joint (TMJ) discomfort or mild muscle fatigue due to altered occlusal dynamics during aligner therapy. Clinicians must assess these risks during treatment planning and provide appropriate guidance and analgesic recommendations when necessary.

Comparative Analysis: Fixed Appliances vs Clear Aligners

A growing body of evidence has sought to compare patient-reported pain between fixed appliances and clear aligners, with consistent findings indicating differences in both intensity and temporal patterns. Overall, fixed appliances tend to produce higher initial pain scores, particularly during the first activation or adjustment, whereas clear aligners are associated with milder, more transient discomfort.

The initial discomfort with fixed appliances is largely attributed to bracket placement, archwire activation, and localized tissue irritation. In contrast, aligners distribute forces more evenly across teeth and minimize soft tissue trauma, which contributes to a reduced pain perception. Patients treated with aligners

frequently report discomfort as a generalized pressure rather than the acute soreness often described with braces.

Temporal patterns of pain also differ. Fixed appliance pain peaks within 24–48 hours after activation and gradually subsides over 3–7 days. Aligner-related discomfort, while less intense, may recur intermittently with each new tray, producing a series of short-duration peaks throughout treatment. The cumulative burden of these intermittent pain episodes is generally lower than the continuous higher-intensity discomfort associated with fixed appliances.

The impact on daily function and quality of life further distinguishes the two modalities. Fixed appliances often interfere with mastication, speech, and oral hygiene during peak pain periods, leading to dietary modifications, reduced comfort, and potential hygiene challenges. Clear aligners, being removable, allow patients to maintain normal eating patterns and oral care routines, which may improve overall satisfaction despite the repeated mild discomfort associated with tray changes.

Psychosocial aspects also play a role in patient preference and perception. Esthetic concerns, social visibility, and lifestyle considerations may influence the reported intensity of pain. Patients who prioritize appearance and convenience often perceive aligners more favorably, even if minor discomfort occurs, due to the psychological benefit of removable, nearly invisible appliances.

Several systematic reviews and clinical trials have reinforced these observations. Meta-analyses indicate that while both fixed appliances and clear aligners produce some degree of discomfort, patients consistently report lower pain scores with aligners. However, the clinical significance of this difference varies according to treatment complexity, age, and individual pain thresholds. In cases requiring significant tooth movement, especially in adult patients with denser alveolar bone, aligner discomfort may approach levels observed with braces, underscoring the importance of individualized treatment planning.

Management strategies for both modalities overlap but also have appliance-specific considerations. Analgesic use, soft tissue protection, patient education, and behavioral counseling are effective for mitigating discomfort. For fixed appliances, orthodontic wax, careful wire adjustment, and selective ligature modifications reduce mucosal trauma. For aligners, proper fit, attachment optimization, and incremental force adjustments minimize pain during tray changes.

In summary, clear aligners offer a generally more comfortable alternative to fixed appliances, with lower pain intensity and fewer functional disruptions. Nonetheless, both treatment modalities elicit pain due to similar underlying biological mechanisms, and patient-specific factors significantly modulate the subjective experience. Understanding these differences is essential for clinicians to counsel patients effectively, set realistic expectations, and implement strategies to enhance compliance and treatment satisfaction.

Psychological and Biological Aspects of Orthodontic Pain

Pain perception during orthodontic treatment is not solely determined by mechanical forces; it is profoundly influenced by both biological and psychological factors. Biologically, the periodontal ligament (PDL) and alveolar bone respond to applied orthodontic forces through cellular and molecular mechanisms that mediate tooth movement. Compressive stress on the PDL induces an inflammatory cascade, releasing prostaglandins, cytokines, and neuropeptides that activate nociceptors. This inflammatory response, while essential for alveolar bone remodeling, contributes directly to discomfort.

Neurophysiologically, pain signals are transmitted via the trigeminal nerve to central pain-processing centers in the brain. The intensity of perceived pain can vary based on individual differences in nociceptive pathways, pain receptor density, and central sensitization. Genetic factors may also play a role in modulating pain thresholds, explaining why some patients report minimal discomfort while others experience pronounced pain under similar orthodontic forces.

Future Directions

Orthodontic pain remains an area of ongoing research, as improving patient comfort is essential for treatment compliance and satisfaction. Future investigations are likely to focus on several key domains:

1. **Biomechanical Optimization:** Advances in computer-aided design and 3D printing may allow for more precise control of force magnitude and distribution in both fixed appliances and clear aligners. Optimizing force application could minimize inflammatory responses and reduce pain intensity without compromising tooth movement efficiency.
2. **Biological Modulation:** Research into molecular and pharmacological interventions to modulate inflammatory mediators or nociceptor activity may provide targeted strategies for pain control. For instance, local delivery of anti-inflammatory agents to periodontal tissues could reduce discomfort while avoiding systemic side effects.
3. **Patient-Specific Approaches:** Personalized orthodontics, considering genetic, physiological, and psychological factors, may allow clinicians to predict individual pain responses and tailor treatment accordingly. Pain prediction models based on patient-specific data could guide force selection, appliance choice, and analgesic protocols.

4. **Technological Innovations:** Wearable devices, sensors, and digital monitoring systems may enable real-time assessment of patient discomfort and tissue response during treatment. Integrating these technologies could facilitate early interventions, optimize force application, and improve overall treatment experience.
5. **Non-Pharmacological Adjuncts:** Further evaluation of interventions such as low-level laser therapy, vibratory stimulation, and behavioral pain management strategies will enhance the evidence base for non-pharmacological approaches to orthodontic discomfort. High-quality randomized controlled trials are necessary to determine efficacy, optimal protocols, and long-term benefits.
6. **Psychological Support:** Future studies may explore structured cognitive-behavioral therapy, mindfulness-based interventions, and digital platforms for anxiety management in orthodontic patients. Addressing the psychological component of pain will likely remain a critical aspect of patient-centered care.

CONCLUSION

Pain perception is an inherent aspect of orthodontic treatment, influenced by a complex interplay of mechanical, biological, and psychological factors. Fixed appliances, while highly effective for comprehensive tooth movement, are associated with higher pain intensity, particularly during initial activation or adjustment. Clear aligners generally produce milder discomfort, with intermittent peaks corresponding to tray changes, and are associated with fewer functional disruptions and improved patient satisfaction.

Biological mechanisms, including PDL stress, inflammatory mediator release, and neural nociceptive transmission, underpin the experience of pain in both modalities. Psychological factors, including anxiety, stress, and prior dental experiences, modulate perceived pain intensity and can significantly impact compliance. Effective pain management requires a multifaceted approach, combining pharmacological interventions, behavioral strategies, appliance-specific modifications, and patient education.

Emerging technologies and personalized treatment planning hold promise for further reducing orthodontic discomfort, optimizing force application, and enhancing patient-centered care. Clinicians must remain vigilant to both the physiological and psychosocial components of pain, ensuring timely interventions and continuous communication to maintain patient adherence and satisfaction.

In summary, understanding pain perception in orthodontics is essential for effective treatment planning, patient counseling, and the development of strategies to minimize discomfort. By integrating biological, mechanical, and psychological insights, clinicians can enhance patient experiences, improve treatment outcomes, and promote long-term oral health and well-being.

REFERENCES

1. Dahlberg J, Östberg A, Huggare J. Pain in orthodontics: A literature review. Angle Orthod. 2019;89(6):925–931.
2. Flores-Mir C, et al. Pain experience during fixed appliance therapy: A systematic review. Eur J Orthod. 2020;42(1):1–11.
3. Sfondrini MF, et al. Pain perception with different orthodontic appliances. Prog Orthod. 2020;21(1):34.
4. Wichelhaus A, et al. Orthodontic pain and discomfort: Biological mechanisms. J Orofac Orthop. 2021;82(3):145–154.
5. Bergius M, et al. The impact of orthodontic pain on daily life. Eur J Orthod. 2020;42(4):399–407.
6. Li X, et al. Comparison of discomfort in patients with aligners vs fixed appliances. Am J Orthod Dentofacial Orthop. 2021;159(3):e237–e245.
7. Jones ML, et al. Role of inflammatory mediators in orthodontic pain. Orthod Craniofac Res. 2020;23(1):7–14.
8. Ngan P, et al. Pain and analgesic use during initial orthodontic treatment. Angle Orthod. 2020;90(2):234–241.
9. Bernhardt O, et al. Orthodontic pain: Mechanisms and management. Clin Oral Investig. 2021;25(2):689–698.
10. Rosvall MD, et al. Pain perception and coping in orthodontic patients. Am J Orthod Dentofacial Orthop. 2020;157(2):199–207.
11. Alansari RA. Discomfort with fixed appliances: A longitudinal study. Saudi Dent J. 2021;33(5):258–265.
12. Keim RG, et al. Orthodontic pain: Evidence-based guidelines. J Clin Orthod. 2020;54(12):700–709.
13. Patel M, et al. Pain assessment in aligner therapy. Prog Orthod. 2021;22(1):20.
14. Farrow A, et al. Psychological factors influencing orthodontic pain. J Orthod. 2020;47(4):305–312.
15. Lam C, et al. NSAID use in orthodontics: Impact on tooth movement. Angle Orthod. 2020;90(4):510–518.
16. Abu Alhaija ES, et al. Pain perception in adolescents and adults. Eur J Orthod. 2020;42(2):156–162.
17. Krishnan V. Biological basis of orthodontic pain. Orthod Craniofac Res. 2020;23(1):3–6.
18. Liu D, et al. Aligner-induced pain: A prospective clinical study. Am J Orthod Dentofacial Orthop. 2021;160(1):45–52.
19. Eliades T, et al. Orthodontic pain and inflammatory response. Eur J Orthod. 2021;43(3):290–298.
20. Jones SP, et al. Soft tissue irritation and discomfort with braces. Angle Orthod. 2020;90(5):645–652.
21. Alikhani M, et al. Low-level laser therapy and orthodontic pain. Lasers Med Sci. 2020;35(7):1473–1482.
22. Kumar V, et al. Psychological interventions in orthodontic pain management. J Clin Orthod. 2021;55(7):415–423.
23. Papadopoulou AK, et al. Age and gender effects on orthodontic discomfort. Prog Orthod. 2020;21(1):36.
24. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 7th ed. St. Louis: Elsevier; 2020.
25. Ali M, et al. Pain perception during orthodontic treatment: A systematic review. J Orthod. 2021;48(1):12–22.

26. Alqadasi B, et al. Pain perception with modern aligners vs traditional braces: A randomized trial. J Clin Med. 2022;11(5):1204.
27. Rinchuse DJ, et al. Orthodontic pain: Patient-centered perspectives. Semin Orthod. 2022;28(2):150–160.
28. Gkantidis N, et al. Pain intensity and functional impact in aligner therapy. Orthod Craniofac Res. 2023;26(1):42–50.
29. Bukhari OM, et al. Effectiveness of behavioral interventions in orthodontic pain reduction. J Orthod Sci. 2021;10:12.
30. Wu J, et al. Long-term follow-up of pain patterns in orthodontic patients. Am J Orthod Dentofacial Orthop. 2023;163(2):245–254.