



QUALITY IN SPORT

eISSN 2450-3118 · Open Access · Peer-reviewed

apcz.umk.pl/QS Nicolaus Copernicus University in Toruń



Cite as: PERSKI, Karol, ZARZYCKA, Marta, LOREK, Julia, CHRABĄSZCZ, Joanna, KUREK, Maria Michalina, GADZALSKI, Krzysztof, GRZYWNA, Wojciech, BALTYZAR, Konstancja Anna and POLIT-RÓŻYCKA, Oliwia Kinga. Pain, discomfort and oral health-related quality of life in clear aligner therapy: a contemporary narrative review. *Quality in Sport*. 2026;58:72664. <https://doi.org/10.12775/QS.2026.58.72664>

ARTICLE TIMELINE

Received: 26.05.2026. Accepted: 03.06.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines: Medical Sciences; Health Sciences.

Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Nauki medyczne; Nauki o zdrowiu. © The Authors 2026.

OPEN ACCESS · CC BY-NC-SA 4.0 This article is published with open access under the License Open Journal Systems of Nicolaus Copernicus University in Toruń, Poland, and is distributed under the terms of the Creative Commons Attribution Non-commercial Share Alike License (<http://creativecommons.org/licenses/by-nc-sa/4.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the work is properly cited. The authors declare no conflict of interest regarding the publication of this paper.

Pain, discomfort and oral health-related quality of life in clear aligner therapy: a contemporary narrative review

Karol Perski, ORCID: <https://orcid.org/0009-0009-7433-2554>

Email: kperski1@gmail.com

mjkstomatologia.pl Dental Clinic, ul. Chrzanowska 3/75, 01-319 Warsaw, Poland

Marta Zarzycka, ORCID: <https://orcid.org/0009-0004-2416-1789>

Email: zarzycka.marta.julia@gmail.com

EMC Medical Institute in Wrocław, ul. Bolesława Krzywoustego 290, 51-312 Wrocław, Poland

Julia Lorek, ORCID: <https://orcid.org/0009-0000-4738-074X>

E-mail: julka.lorek9@gmail.com

University Clinical Hospital in Wrocław, Borowska 213, 50-556 Wrocław, Poland

Joanna Chrabąszcz, ORCID: <https://orcid.org/0009-0005-1742-1607>

Email: asia.chrab@interia.pl

Provincial Integrated Hospital in Kielce, ul. Grunwaldzka 45, 25-736 Kielce, Poland

Maria Michalina Kurek, ORCID: <https://orcid.org/0009-0005-1853-649X>

E-mail: marysia_kurek@icloud.com

Wojewódzki Szpital Zespolony w Kielcach, ul. Grunwaldzka 45, 25-736 Kielce, Polska

Krzysztof Gadzalski, ORCID: <https://orcid.org/0009-0000-6821-3350>

E-mail: gadzal@interia.pl

Wojewódzki Szpital Specjalistyczny im. św. Rafała w Czerwonej Górze, Czerwona Góra 10,
26-060 Chęciny, Polska

Wojciech Grzywna, ORCID: <https://orcid.org/0009-0002-7541-8922>

E-mail: wojtek.grzywna@onet.pl

Provincial Integrated Hospital in Kielce, ul. Grunwaldzka 45, 25-736 Kielce, Poland

Konstancja Anna Baltyzar, ORCID: <https://orcid.org/0009-0007-6723-8477>

E-mail: konstancjabaltyzar@yahoo.com

Wojewódzki Szpital Zespolony w Kielcach, ul. Grunwaldzka 45, 25-736 Kielce, Polska

Oliwia Kinga Polit-Różycka, ORCID: <https://orcid.org/0009-0006-7764-851X>

E-mail: oliwkapolit9@gmail.com

Wojewódzki Szpital Specjalistyczny im. św. Rafała w Czerwonej Górze, Czerwona Góra 10,
26-060 Chęciny, Polska

Corresponding Author

Karol Perski, E-mail: kperski1@gmail.com

Abstract

Background

Clear aligner therapy (CAT) has become an increasingly popular alternative to conventional fixed orthodontic appliances due to its aesthetic appearance, enhanced comfort, and improved convenience. In contemporary orthodontics, growing attention has been directed toward patient-reported outcomes, including pain, discomfort, and oral health-related quality of life (OHRQoL), as important indicators of treatment success.

Aim

The aim of this narrative review was to critically evaluate the available evidence regarding pain, discomfort, and oral health-related quality of life in patients undergoing clear aligner therapy.

Material and methods

A comprehensive literature search was conducted using electronic databases, including PubMed, Google Scholar, Scopus, and Web of Science. Studies evaluating patient-reported

outcomes related to pain, discomfort, psychological factors, and OHRQoL in patients treated with clear aligners were included. Prospective and retrospective clinical studies, as well as randomized controlled trials, were analyzed qualitatively. Due to heterogeneity in study designs, assessment methods, and outcome measures, a meta-analysis was not performed.

Results

The reviewed literature indicates that clear aligner therapy is associated with lower pain intensity, decreased discomfort, and improved patient satisfaction compared with conventional fixed orthodontic appliances. Pain and discomfort were found to be most pronounced during the initial phase of treatment and generally declined rapidly over time. Clear aligners were also associated with improved aesthetics, lower psychological burden, enhanced patient acceptance, and more favorable OHRQoL outcomes. Although temporary disturbances in speech and eating function were reported, these effects were generally mild and transient. However, interpretation of the available evidence remains limited because of heterogeneity in study designs, outcome measures, and assessment tools.

Conclusions

Clear aligner therapy represents a patient-centered orthodontic approach associated with improved comfort and favorable patient-reported outcomes while maintaining functional effectiveness. Nevertheless, further high-quality, standardized, and long-term studies are required to strengthen the evidence base and better understand the broader impact of clear aligner therapy on patient-centered orthodontic outcomes.

Key words: clear aligners, orthodontics, pain, discomfort, oral health-related quality of life, OHRQoL, patient-reported outcomes

1. Introduction:

The field of orthodontics has undergone significant changes in recent years, with clear aligner therapy (CAT) emerging as a widely used alternative to conventional orthodontic treatments (COT) for the correction of malocclusions and improvement of dental alignment [1]. Fixed orthodontic appliances, such as brackets and archwires, have traditionally represented the standard treatment approach; however, they are frequently associated with drawbacks including soft tissue irritation, difficulties in maintaining oral hygiene, and pain following appliance activation [2]. Orthodontic aligners offer several advantages, including enhanced aesthetics,

greater comfort, and improved convenience, making them particularly attractive for adult patients seeking orthodontic care [3,4]. Oral health–related quality of life (OHRQoL) is a multidimensional construct that evaluates how oral health influences an individual’s overall well-being, including functional, psychological, and social domains. Clear aligner therapy has been associated with improvements in OHRQoL, particularly through reductions in pain, emotional distress, and functional impairments. These findings suggest that aligners represent a valuable orthodontic modality for patients prioritizing both aesthetic outcomes and quality-of-life benefits [3].

Evidence suggests that patients treated with clear aligners tend to report reduced pain and lower anxiety compared to those undergoing treatment with fixed orthodontic appliances, which may contribute to improved overall patient comfort [1]. Furthermore bracket-based treatment adversely affected patients’ oral health–related quality of life one month after treatment initiation [5]. Also clear aligner therapy has been linked to improved oral health-related quality of life during orthodontic treatment compared with fixed appliances, especially in lower psychological burden, and fewer social difficulties [2]. Therefore CAT is a contemporary orthodontic approach that has become increasingly popular in recent years owing to its convenience, enhanced comfort, and nearly imperceptible appearance [6]. Accordingly, the aim of this study was to critically evaluate the available evidence on pain, discomfort, and oral health–related quality of life in patients undergoing clear aligner therapy.

2. Material and methods

This review was conducted to evaluate the current evidence on pain, discomfort, and oral health–related quality of life associated with clear aligner therapy. A comprehensive literature search was performed using electronic databases, including PubMed, Google Scholar, Scopus, and Web of Science, to identify relevant studies published from 2005. The search strategy combined keywords and Medical Subject Headings (MeSH) such as “clear aligners,” “orthodontic aligners,” “pain,” “discomfort,” and “oral health–related quality of life.”

Studies were included if they assessed patient-reported outcomes related to pain, discomfort, or OHRQoL in individuals undergoing clear aligner therapy. Both prospective and retrospective clinical studies, as well as randomized controlled trials, were considered. Articles not published in English, conference abstracts, and studies lacking relevant outcome measures were excluded. The selection process involved initial screening of titles and abstracts, followed by full-text

evaluation of potentially eligible studies. Data from the included studies were extracted and qualitatively synthesized. Due to heterogeneity in study design, outcome measures, and assessment tools, a meta-analysis was not performed.

3. Discussion

3.1. PAIN AND DISCOMFORT IN CLEAR ALIGNER THERAPY

3.1.1. Biological basis of orthodontic pain

Pain is frequently reported during orthodontic treatment and has a direct impact on patient satisfaction [7]. Clear aligners are associated with a lower level of pain compared with fixed orthodontic appliances [8]. Following the application of orthodontic forces to teeth, significant biological responses are triggered in the surrounding paradental tissues, including both the periodontal structures and the dental pulp [9, 10]. A cascade of self-limiting inflammatory processes involving cellular, vascular, neural, and immunological components occurs in a coordinated manner, leading to both orthodontic pain and tooth movement. These two phenomena are closely interconnected biological events that share local inflammation as a common underlying mechanism [11]. Local inflammatory mediators, such as prostaglandins and bradykinin, stimulate sensory nerve endings, leading to the perception of pain [12, 13]. Therefore, orthodontic pain is primarily driven by inflammatory responses in the periodontal tissues triggered by orthodontic forces. Orthodontic forces induce localized periodontal ischemia, leading to acidosis and activation of acid-sensing ion channels (particularly ASIC3), which initiate nociceptive signaling. This process triggers a cascade of neurogenic and inflammatory mediators that amplify local inflammation and ultimately contribute to orthodontic pain through a self-reinforcing feedback loop [11, 14].

3.1.2. Pain trajectory during aligner therapy

At the beginning, patients experienced low levels of discomfort, which were followed by a moderate increase reaching a peak within the first or second day. Thereafter, discomfort gradually declined throughout the remainder of the first week. By day 7, patients treated with aligners reported minimal discomfort, consistently lower than the initial baseline levels. Compared with fixed orthodontic appliances, aligners are associated with lower levels of discomfort during the first week of treatment. Although baseline pain levels were similar,

patients treated with traditional appliances reported significantly greater discomfort between days 2 and 7. Previous studies have also consistently shown reduced pain in aligner patients compared with those treated with conventional fixed appliances [15-17]. Clear aligner treatment (eg. Invisalign) is associated with lower pain levels compared with edgewise appliances approximately three days after delivery or adjustment during the initial phase (around five weeks) of treatment. Additionally patients reported less pain with aligner treatment compared to the edgewise appliance by the end of treatment [18].

3.1.3. Determinants of pain perception

Reduced pain reported in patients undergoing clear aligner treatment (Invisalign) may be attributed to the fact that removable appliances generate less tension, pressure, sensitivity, and discomfort compared with fixed orthodontic appliances [7]. In most studies, no significant differences in pain perception between males and females were observed during the early stages of orthodontic treatment. Moreover, analyses stratified by sex were infrequently performed [8,15]. Some authors have reported no differences in pain intensity related to patient age in adult populations [16]. Reported causes of pain included gingival pressure, tongue irritation, deformation of the aligner tray, as well as gingival swelling associated with third molars or inadequate oral hygiene [19]. Rotation of teeth achieved with clear aligners is consistently associated with unintended mechanical effects, mainly intrusion and tipping, while reduced control of rotational movement is linked to increased intrusive displacement [20], which may result in greater patient discomfort. Rotations of canines, premolars, and lateral incisors were among the least predictable tooth movements [21].

3.1.4. Impact of Pain on Patient Compliance and Treatment Behavior

Pain adversely affects patient compliance, oral hygiene practices, and attendance at scheduled appointments [15]. Clear aligners were associated with greater patient acceptance and marginally improved compliance, although the difference did not reach statistical significance. These results indicate that aligners may be a suitable option for patients who prioritize comfort [22]. Higher compliance was observed in male patients compared with females, whereas no significant association was found between patient age and compliance levels. Additionally,

treatment duration did not significantly influence patient compliance, with no differences observed across varying treatment time periods [23].

3.2. PATIENT-REPORTED EXPERIENCE DURING CLEAR ALIGNER THERAPY

Recent studies indicate that patients treated with clear aligners (Invisalign) report high satisfaction with aesthetic outcomes and demonstrate improvements in quality of life, particularly in relation to smile appearance as well as chewing and eating functions assessed after treatment [7, 24, 25].

3.2.1. Eating

Studies show that patients undergoing clear aligner therapy experienced fewer disturbances during eating compared to those treated with fixed appliances [24, 26-28]. These patients were less concerned about food trapping and staining of the appliance [19]. No significant differences were observed between the two groups in terms of enjoyment of food or difficulties with swallowing [27]. Additionally patients undergoing clear aligner therapy reported a decreased tendency to snack, associated with the necessity of removing the appliance during eating [29]. One study evaluated chewing efficiency in patients wearing clear aligners compared with conditions without aligners. The authors investigated whether the presence of aligners affects masticatory function and comfort during eating. It was demonstrated that chewing efficiency remained comparable in both conditions, while any reported discomfort was mild and well tolerated by most participants [30].

3.2.2. Speech

Clear aligner therapy may alter tongue placement and airflow patterns, which can lead to temporary speech articulation errors [31]. Although speech difficulties may be expected with clear aligner therapy and are generally reported at a similar incidence to fixed appliances, some evidence indicates that they may be perceived more frequently and with greater intensity during aligner wear [32,33]. At the beginning of treatment, patients may notice subtle alterations in speech, such as mild lisping or minor pronunciation changes as the tongue adapts to the presence of aligners. However, these effects are typically short-lived and gradually resolve as individuals become accustomed to wearing the appliance, with speech function generally

recovering within a few weeks [32,34]. The time required for full adaptation varies considerably, ranging from approximately one week to up to two months in some cases [31,32]. The phonemes most commonly affected were fricative sounds produced in the alveolar region [35]. Reports indicate that several phonemes, including /ch/, /dz/, /sh/, /f/, /s/, and /t/, may be affected during orthodontic treatment, leading to changes in pronunciation and speech clarity in conversation [34, 36]. Acoustic analysis showed that the /s/ phoneme was the most affected. Clear aligners influenced speech during reading tasks, leading patients to reduce their speaking rate in order to improve articulation [32]. Orthodontists should inform patients during treatment planning that clear aligners may cause temporary speech changes [31].

3.2.3. Sleeping

Sleep has been a subject of considerable interest in multiple studies and scientific publications. No significant differences in sleep quality were observed between patients treated with clear aligners and those treated with fixed orthodontic appliances [37,38]. On the other hand, fixed appliance therapy was associated with greater sleep difficulties compared to clear aligner therapy [25]. However, further studies are necessary to better clarify and confirm the impact of different orthodontic modalities on sleep quality.

3.2.4. Psychological factors

Clear aligners are a contemporary orthodontic modality that provide benefits including enhanced comfort, superior aesthetics, and improved patient convenience. One study demonstrated that patients treated with clear aligners reported significantly lower pain levels, reduced anxiety, and better oral health-related quality of life compared with those treated with fixed appliances. These findings suggest that clear aligner therapy may represent a more comfortable and less stressful treatment option, particularly during the initial phase of orthodontic treatment [28]. However a greater number of additional aligners required during the refinement phase was associated with increased levels of patient anxiety [39]. The invisibility of aligners was identified as the primary factor motivating patients to choose this treatment, with improved self-confidence being the main expectation. High satisfaction levels were reported across several aspects of therapy, including dental and facial aesthetics, comfort, and ease of maintaining oral hygiene [40]. It was found that minimal impact on social

interactions was experienced by patients treated with clear aligners and lingual appliances, whereas restrictions in social interactions were reported by those undergoing fixed appliance therapy [29]. Overall, psychological factors play a crucial role in shaping patient-reported experience and perceived treatment outcomes during clear aligner therapy.

3.2.5. Satisfaction

Patients treated with clear aligners reported greater satisfaction with appliance aesthetics compared to those with fixed appliances, while both groups were equally willing to recommend their treatment and expressed no interest in alternative options [27,29,41]. Greater satisfaction with clear aligner therapy was reported by 90.7% of patients who had previously undergone treatment with fixed appliances. This finding was suggested to be associated with the lower intensity and shorter duration of pain experienced with aligners [42].

3.2.6. Evaluation of patient-reported outcomes and OHRQoL

Various qualitative assessment tools were used to evaluate patient experiences during clear aligner therapy. In contemporary orthodontics, growing emphasis has been placed on patient-reported outcomes and oral health-related quality of life, reflecting a shift toward more patient-centered approaches to treatment evaluation [39]. OHRQoL is considered a multidimensional construct reflecting the functional, psychological, and social impact of oral health status [5]. The Oral Health Impact Profile-14 (OHIP-14) was the assessment tool most frequently applied in the included studies. This questionnaire comprises 14 items designed to evaluate the influence of treatment on oral health-related quality of life [43]. Although there is a lack of standardization across studies regarding study design and reporting of OHIP-14 scores, which limits comparability of findings and contributes to the overall low quality of evidence in this field [44].

<u>Abbreviation</u>	<u>Full term</u>
OHIP-14	Oral Health Impact Profile-14
VAS	Visual Analogue Scale
OHRQoL	Oral Health-Related Quality of Life
MPQ	McGill Pain Questionnaire
STAI	State-Trait Anxiety Inventory
PSQ	Patient Satisfaction Questionnaire
ESS	Epworth Sleepiness Scale
DIDL	Dental Impacts on Daily Living Index
PSQI	Pittsburgh Sleep Quality Index
SRAS	Self-Rating Anxiety Scale
WHOQOL-BREF	World Health Organization Quality of Life – Brief Version

Table 1. Summary of instruments used for assessment of pain, psychological factors, and oral health-related quality of life in clear aligner therapy studies

4. Clinical Implications

4.1. Patient-centered orthodontics

Contemporary orthodontics is increasingly shifting towards a patient-centered approach, where treatment success is no longer assessed solely on occlusal outcomes but also on patient-reported experiences and quality-of-life measures. Clear aligner therapy is well aligned with this paradigm, as it enables greater consideration of patient preferences, particularly regarding aesthetics, comfort, and lifestyle compatibility. This review suggests that integrating patient-reported outcomes such as pain, psychological well-being, and satisfaction into clinical decision-making is essential for optimizing treatment acceptance and adherence.

4.2. Clinical relevance of findings

The available evidence suggests that clear aligner therapy is associated with reduced pain intensity, improved aesthetic perception, and more favorable psychological outcomes compared with fixed orthodontic appliances. These factors may contribute to improved treatment acceptance and enhanced patient experience, with particular emphasis on initial stages of orthodontic therapy. Although speech and eating functions may be temporarily affected, these disturbances are generally mild and transient. Taken together, the clinical relevance of these findings lies in the potential of clear aligners to enhance patient comfort without compromising functional outcomes.

4.3. Treatment planning implications

This review highlights the significance of individualized treatment planning in orthodontics. Clinicians should take into account patient-specific factors such as aesthetic expectations, tolerance to pain, psychological profile, and anticipated compliance when choosing between clear aligners and fixed appliances. Patients should be adequately informed about potential short-term effects, including initial discomfort, transient speech alterations, and adaptation periods. Proper patient education and expectation management may improve adherence and reduce treatment-related anxiety, particularly during the early and refinement phases of therapy.

4.4. Limitations of evidence

Despite growing interest in patient-reported results in orthodontics, the current evidence base is limited by considerable heterogeneity in study designs, outcome measures, and reporting methods. Variability in assessment instruments, particularly for OHRQoL and pain evaluation, limits direct comparison between studies. Additionally, many studies rely on subjective measures and short follow-up periods, which may not fully capture long-term patient experiences. The lack of standardized protocols for measuring patient-reported outcomes further weakens the overall strength of the available evidence.

4.5. Future research directions

Future research should focus on the development of standardized and validated instruments for assessing patient-reported outcomes in orthodontics to enhance comparability between studies. Long-term studies with extended follow-up periods are needed to better evaluate the long-term effect of clear aligner therapy on OHRQoL and psychological well-being. Additional studies that focus on the refinement phase of treatment and its association with patient anxiety and satisfaction are also warranted. Furthermore high-quality randomized controlled trials assessing clear aligners versus fixed appliances across different OHRQoL domains would provide stronger evidence to guide clinical decision-making.

5. Conclusion

Clear aligner therapy is associated with reduced pain intensity, decreased discomfort levels, and more positive patient-reported outcomes compared with conventional fixed orthodontic appliances. The available literature suggests that CAT has a positive effect on oral health-related quality of life, particularly in psychological and aesthetic domains, while maintaining comparable functional outcomes.

Pain and discomfort are most prominent during the initial phase of treatment but generally decrease rapidly, suggesting effective short-term adaptation. Furthermore, speech and eating disturbances, when present, are usually mild and transient. Psychological factors such as anxiety, satisfaction, and self-perceived aesthetics, are important in shaping the overall treatment experience and may contribute to improved acceptance and adherence to aligner therapy.

However, the interpretation of available evidence is constrained by substantial heterogeneity in study designs, outcome measures, and assessment instruments, as well as a lack of standardized protocols for assessing patient-reported outcomes. This limits direct comparison across studies and reduces the overall strength of the conclusions.

In conclusion, clear aligner therapy represents a patient-centered orthodontic approach that improves comfort and perceived treatment experience while maintaining functionality effectiveness. Further high-quality, standardized, and long-term studies remain necessary to strengthen the evidence base and better understand its broader impact on patient-centered orthodontic outcomes.

Disclosure

Supplementary Materials

Not applicable.

Author Contribution Statement

Conceptualization: Karol Perski, Marta Zarzycka

Methodology: Karol Perski, Julia Lorek

Software: Not applicable.

Formal analysis: Karol Perski, Julia Lorek, Joanna Chrabąszcz, Krzysztof Gadzalski, Wojciech Grzywina, Oliwia Kinga Polit-Różycka

Investigation: Karol Perski, Marta Zarzycka, Julia Lorek, Joanna Chrabąszcz, Maria Michalina Kurek, Krzysztof Gadzalski, Wojciech Grzywina, Konstancja Anna Baltyzar, Oliwia Kinga Polit-Różycka

Resources: Karol Perski, Marta Zarzycka, Julia Lorek, Maria Michalina Kurek,

Data curation: Karol Perski, Marta Zarzycka, Julia Lorek, Konstancja Anna Baltyzar, Oliwia Kinga Polit-Różycka

Writing - rough preparation: Karol Perski, Marta Zarzycka, Julia Lorek

Writing - review and editing: Karol Perski, Marta Zarzycka, Julia Lorek, Joanna Chrabąszcz, Maria Michalina Kurek, Krzysztof Gadzalski, Wojciech Grzywna, Konstancja Anna Baltyzar, Oliwia Kinga Polit-Różycka

Supervision: Karol Perski

Project administration: Karol Perski

All authors have read and agreed with the published version of the manuscript.

Funding Statement

The authors did not receive special funding.

Institutional Review Board Statement

Not applicable.

Data Availability Statement

Not applicable.

Acknowledgements Statement

Not applicable.

Conflicts of Interest Statement

The authors declare no conflict of interest.

Declaration of generative AI and AI-assisted technologies in the writing process

In preparing this work, the authors used ChatGPT (OpenAI) for language editing, grammar correction and improvement of text clarity. After using this tool, the authors carefully reviewed and edited the content as necessary and accept full responsibility for the content of the publication.

References:

1. Budhreja SN, Nanjannawar LG, Agrawal JM, Shetti SS, Fulari SG, Patil HS. Pain perception and sEMG of masticatory muscle in clear aligners vs. conventional

- orthodontics: A systematic review and meta-analysis. *Dent Res J*. 2025;22:29. doi:10.4103/drj.drj_367_24.
2. Kanagasabapathy B, Kumar V, Priya RP, Varghese C, Thirivikhraman K, Kuppusamy VR. Evaluation of effects of clear aligners vs fixed appliances on oral health related quality of life during orthodontic treatment: A prospective study. *J Pharm Bioall Sci*. 2025;17:S3328-30. doi:10.4103/jpbs.jpbs_1397_25.
 3. Dash KS, DCosta O, Dhopte A, Kumari S, Dave M, Bagde H, et al. Impact of orthodontic aligner treatment on oral health-related quality of life. *J Pharm Bioall Sci*. 2025;17:S1445-7. doi:10.4103/jpbs.jpbs_1834_24.
 4. Papageorgiou SN, Koletsi D, Iliadi A, Peltomäki T, Eliades T. Treatment outcome with orthodontic aligners and fixed appliances: A systematic review with meta-analyses. *Eur J Orthod*. 2018;40:629-36. doi:10.1093/ejo/cjz094.
 5. Correa L, Albaladejo A, Curto A. A longitudinal pilot study examining the influence of the orthodontic system chosen in adult patients (brackets versus aligners) on oral health-related quality of life and anxiety. *BMC Oral Health*. 2024 Jun 27;24(1):745. doi: 10.1186/s12903-024-04464-7. PMID: 38937720; PMCID: PMC11212429.
 6. AlMogbel A. Clear aligner therapy: up to date review article. *J Orthodont Sci*. 2023;12:37. doi:10.4103/jos.jos_30_23.
 7. Cardoso PC, Espinosa DG, Mecenas P, Flores-Mir C, Normando D. Pain level between clear aligners and fixed appliances: a systematic review. *Prog Orthod*. 2020 Jan 20;21(1):3. doi: 10.1186/s40510-019-0303-z. PMID: 31956934; PMCID: PMC6970090.
 8. Pereira D, Machado V, Botelho J, Proença L, Mendes JJ, Delgado AS. Comparison of pain perception between clear aligners and fixed appliances: a systematic review and meta-analysis. *Appl Sci*. 2020;10:4276. doi:10.3390/app10124276
 9. Levrini L, Sacerdote P, Moretti S, et al. Changes of substance P in the crevicular fluid in relation to orthodontic movement preliminary investigation. *ScientificWorldJournal*. 2013;2013:896874. doi:10.1155/2013/896874.
 10. Chavarría-Bolaños D, Martínez-Zumaran A, Lombana N, et al. Expression of substance P, calcitonin gene-related peptide, β -endorphin and methionine-enkephalin in human

- dental pulp tissue after orthodontic intrusion: a pilot study. *Angle Orthod.* 2014;84(3):521-526. doi:10.2319/060313-423.1.
11. Long H, Wang Y, Jian F, et al. Current advances in orthodontic pain. *Int J Oral Sci.* 2016;8:67-75. doi:10.1038/ijos.2016.24
 12. Sacerdote P, Levrini L. Peripheral mechanisms of dental pain: the role of substance P. *Mediators Inflamm.* 2012;2012:951920. doi:10.1155/2012/951920.
 13. Wang H, Kohno T, Amaya F, et al. Bradykinin produces pain hypersensitivity by potentiating spinal cord glutamatergic synaptic transmission. *J Neurosci.* 2005;25(35):7986-7992. doi:10.1523/JNEUROSCI.2393-05.2005.
 14. Jeon HH, Teixeira H, Tsai A. Mechanistic insight into orthodontic tooth movement based on animal studies: a critical review. *J Clin Med.* 2021;10:1733. doi:10.3390/jcm10081733
 15. White DW, Julien KC, Jacob H, Campbell PM, Buschang PH. Discomfort associated with Invisalign and traditional brackets: A randomized, prospective trial. *Angle Orthod.* 2017 Nov;87(6):801-808. doi: 10.2319/091416-687.1. Epub 2017 Jul 28. PMID: 28753032; PMCID: PMC8317568.
 16. Antonio-Zancajo L, Montero J, Garcovich D, Alvarado-Lorenzo M, Albaladejo A, Alvarado-Lorenzo A. Comparative analysis of periodontal pain according to the type of precision orthodontic appliances: vestibular, lingual and aligners. A prospective clinical study. *Biology.* 2021;10:379. doi:10.3390/biology10050379
 17. Vitale MC, Falzinella C, Sfondrini MF, Defabianis P, Scribante A. The use of questionnaires in pain assessment during orthodontic treatments: a narrative review. *Medicina.* 2023;59:1681. doi:10.3390/medicina59091681
 18. Fujiyama K, Honjo T, Suzuki M, et al. Analysis of pain level in cases treated with Invisalign aligner: comparison with fixed edgewise appliance therapy. *Prog Orthod.* 2014;15:64. doi:10.1186/s40510-014-0064-7
 19. Chong H, Peh J, Weir T, Meade MJ. Patient experiences with clear aligners: a scoping review. *Eur J Orthod.* 2025;47(3):cjaf017. doi:10.1093/ejo/cjaf017
 20. Huang Y, Wong H, Yang P. Tooth rotational control with varying attachment configurations in clear aligners under compromised periodontal ligament support: a

finite element study. *BMC Oral Health*. 2026;26:745. doi:10.1186/s12903-026-08200-1

21. Bilello G, Fazio M, Amato E, et al. Accuracy evaluation of orthodontic movements with aligners: a prospective observational study. *Prog Orthod*. 2022;23:12. doi:10.1186/s40510-022-00406-7
22. Alfawzan AA. Evaluation of patient acceptance and compliance with clear aligners vs. lingual braces: a randomized trial. *J Pharm Bioall Sci*. 2024;16(Suppl 1):S546-S548. doi:10.4103/jpbs.jpbs_854_23
23. Timm LH, Farrag G, Baxmann M, Schwendicke F. Factors influencing patient compliance during clear aligner therapy: a retrospective cohort study. *J Clin Med*. 2021;10:3103. doi:10.3390/jcm10143103
24. Flores-Mir C, Brandelli J, Pacheco-Pereira C. Patient satisfaction and quality of life status after 2 treatment modalities: Invisalign and conventional fixed appliances. *Am J Orthod Dentofacial Orthop*. 2018;154(5):639-644. doi:10.1016/j.ajodo.2018.01.013.
25. Pacheco-Pereira C, Brandelli J, Flores-Mir C. Patient satisfaction and quality of life changes after Invisalign treatment. *Am J Orthod Dentofacial Orthop*. 2018;153(6):834-841. doi:10.1016/j.ajodo.2017.10.023.
26. Kumari S, Goyal M, Kumar M, et al. Percentage of patients shifting to another treatment modality: an experience-guided decision. *Dental Press J Orthod*. 2024;29:e2423133. doi:10.1590/2177-6709.29.1.e2423133.oar
27. Alajmi S, Shaban A, Al-Azemi R. Comparison of short-term oral impacts experienced by patients treated with Invisalign or conventional fixed orthodontic appliances. *Med Princ Pract*. 2020;29:382-388. doi:10.1159/000505459
28. Jaber ST, Hajeer MY, Burhan AS, et al. The effect of treatment with clear aligners versus fixed appliances on oral health-related quality of life in patients with severe crowding: a one-year follow-up randomized controlled clinical trial. *Cureus*. 2022;14:e25472. doi:10.7759/cureus.25472
29. Johal A, Damanhuri SH, Colonio-Salazar F. Adult orthodontics, motivations for treatment, choice, and impact of appliances: a qualitative study. *Am J Orthod Dentofacial Orthop*. 2024;166:36-44. doi:10.1016/j.ajodo.2024.02.009.

30. Levrini L, Bocchieri S, Mauceri F, Saran S, Carganico A, Zecca PA, Segù M. Chewing efficiency test in subjects with clear aligners. *Dent J (Basel)*. 2023;11:68. doi:10.3390/dj11030068
31. Baeshen AH, El-Bialy T, Alshehri A, et al. The effect of clear aligners on speech: a systematic review. *Eur J Orthod*. 2023;45:119. doi:10.1093/ejo/cjac018.
32. Al-Dboush R, Al-Zawawi E, El-Bialy T. Impact of clear aligner therapy on speech: does clear aligner therapy cause any speech difficulty? *Evid Based Dent*. 2024;25:27-28. doi:10.1038/s41432-024-00969-w.
33. Wang D, Firth F, Bennani F, Farella M, Mei L. Immediate effect of clear aligners and fixed appliances on perioral soft tissues and speech. *Orthod Craniofac Res*. 2023 Aug;26(3):425-432. doi: 10.1111/ocr.12625. Epub 2022 Dec 20. PMID: 36495315.
34. Dhanu Sri T, Angrish N, Chandrasekharan D, et al. Pain level in clear aligners and its effects in speech: literature review. *Int J Curr Sci Res Rev*. 2024;7(10):8048-8052. doi:10.47191/ijcsrr/V7-i10-65
35. Pogal-Sussman-Gandia CB, Tabbaa S, Al-Jewair T. Effects of Invisalign® treatment on speech articulation. *Int Orthod*. 2019;17(3):513-518. doi:10.1016/j.ortho.2019.06.011
36. Paley JS, Cisneros GJ, Nicolay OF, LeBlanc EM. Effects of fixed labial orthodontic appliances on speech sound production. *Angle Orthod*. 2016;86:462-467. doi:10.2319/052415-351.1.
37. Hakami Z. Comparison of sleep quality between clear aligner and fixed appliance orthodontic therapies. *J Orthod*. 2023. doi:10.1016/j.ejwf.2023.09.002
38. Diddige R, Negi G, Kiran K, et al. Comparison of pain levels in patients treated with 3 different orthodontic appliances: a randomized trial. *Med Pharm Rep*. 2020;93:81-88. doi:10.15386/mpr-1311.
39. Xu L, Li H, Mei L, et al. Aligner treatment: patient experience and influencing factors. *Aust Orthod J*. 2022;38:88-95. doi:10.21307/aoj-2022.008
40. Alfawal AMH, Burhan AS, Mahmoud G, Ajaj MA, Nawaya FR, Hanafi I. The impact of nonextraction orthodontic treatment on oral health-related quality of life: clear aligners versus fixed appliances-a randomized controlled trial. *Eur J Orthod*. 2022;44(6):595-602. doi:10.1093/ejo/cjac012.
41. Azaripour A, Weusmann J, Mahmoodi B, Peppas D, Gerhold-Ay A, Van Noorden CJ, et al. Braces versus Invisalign®: gingival parameters and patients' satisfaction during

treatment: a cross-sectional study. *BMC Oral Health*. 2015;15:69. doi:10.1186/s12903-015-0060-4.

42. Caldas W, Bonin FA, Vianna CP, et al. Influence of pain duration and severity on oral health-related quality of life and patient satisfaction during adult treatment with clear aligners. *Prog Orthod*. 2024;25:18. doi:10.1186/s40510-024-00514-6
43. Antonio-Zancajo L, Montero J, Albaladejo A, et al. Pain and oral health-related quality of life in orthodontic patients during initial therapy with conventional, low-friction, and lingual brackets and aligners (Invisalign): a prospective clinical study. *J Clin Med*. 2020;9:2088. doi:10.3390/jcm9072088
44. Andiappan M, Gao W, Bernabé E, Kandala NB, Donaldson AN. Malocclusion, orthodontic treatment, and the Oral Health Impact Profile (OHIP-14): Systematic review and meta-analysis. *Angle Orthod*. 2015 May;85(3):493-500. doi: 10.2319/051414-348.1. Epub 2014 Aug 26. PMID: 25157973; PMCID: PMC8612413.