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Original Article

Comparison of pain, anxiety, and oral health-related quality of life in orthodontic treatment using traditional, self-ligating, and clear aligner systems

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Abstract *Background/purpose:* The choice of orthodontic appliance can profoundly influence the patient experience. While conventional, self-ligating, and clear aligner systems are widely used, direct comparisons of their effects on patient comfort and well-being remain limited. This prospective study compared changes in pain, anxiety, and oral health-related quality of life (OHRQoL) among adult patients treated with these three modalities during the critical first month of orthodontic treatment.
Materials and methods: Ninety-seven adult participants were allocated to traditional, self-ligating, or Invisalign groups, ensuring comparable case complexity across treatments. Pain (VAS), anxiety (GAD-7), and OHRQoL (OHIP-14) were evaluated at baseline (T0), one week (T1), and one month (T2). Changes over time were analyzed using Generalized Estimating Equations (GEE) to account for within-subject correlations and to compare temporal trends among treatment groups.
Results: At T1, the Invisalign group reported significantly lower pain levels (VAS: 2.95) than the traditional (5.20) and self-ligating (4.85) groups. Similarly, the decline in OHRQoL was

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substantially less pronounced in the Invisalign group, primarily due to significantly smaller impacts on the functional limitation and physical pain subdomains ($p < 0.001$). Anxiety levels decreased similarly across all groups over time.
Conclusion: Clear aligners are associated with a notably more comfortable adaptation period, producing less pain and functional disruption than both traditional and selfligating fixed appliances. These findings provide robust, domain-specific evidence to support shared decision-making, enabling clinicians to better manage patient expectations and tailor treatment choices to individual preferences.

Introduction

Orthodontics has evolved beyond a singular goal of achieving optimal occlusion. Orthodontics has adopted a comprehensive, patient-centered philosophy.[1] In this modern paradigm, patients' subjective experiences, including pain, anxiety, and effects on daily life, are recognized as key components of treatment success.[2,3] This paradigm shift is particularly relevant because of the increasing number of adult patients seeking orthodontic treatment. Older adults often have higher expectations regarding esthetics and comfort than do adolescents.[4] A key decision in any orthodontic plan is the choice of appliance type. Traditional fixed appliances remain the gold standard for treatment. Technological advancements have introduced alternatives, such as self-ligating braces and clear aligner systems, each with purported benefits in terms of treatment efficacy, esthetics, and patient comfort.[5,6]

Historically, orthodontics has predominantly involved a biomechanical clinical perspective, focusing on the precision of tooth movement and the final occlusal outcomes. This perspective has often overlooked the profound psychosocial and behavioral dimensions of the treatment process. Orthodontic treatment is not merely a clinical procedure. Instead, it is a long-term journey that deeply intersects with the patient's self-perception, social interactions, and daily routines. For many patients, the motivation for treatment originates from psychosocial concerns, such as dissatisfaction with their appearance, low self-esteem, or even experiences of bullying related to their malocclusion.[40] The treatment process itself imposes major behavioral demands, requiring high levels of patient compliance in terms of oral hygiene, dietary adjustments, and, in the case of aligners, ensuring consistent wear. Clinical approaches focusing only on technical success while failing to address the patient's psychological adaptation, social comfort, and behavioral challenges do not provide comprehensive or "whole-person" care.

Traditional edgewise braces, which involve elastomeric or wire ligatures, have long been associated with major initial discomfort and esthetic concerns.[7,8] In procedures involving traditional edgewise braces, the friction generated by ligation is believed to necessitate greater initial forces to overcome resistance, which in turn leads to a more pronounced inflammatory response in the periodontal ligament and, consequently, more intense pain.[9] To address these limitations, self-ligating braces were developed, featuring a built-in gate or clip mechanism to secure the archwire. These braces may create a lower-friction environment, enabling lighter, more continuous forces, which may translate to less pain and faster initial alignment.[10,11] Clinical evidence remains equivocal. Several randomized clinical trials and systematic reviews comparing the experiences of pain between patients with traditional and self-ligating systems have yielded conflicting results. Some studies have demonstrated a modest benefit for self-ligating brackets in the first few days. Other studies have reported no significant difference over the first week and beyond.[12–14]

Clear aligner therapy (eg, Invisalign) is a distinct approach that utilizes a series of removable, custom-made thermoplastic trays to incrementally move teeth.[15] This approach provides better esthetics and facilitates the maintenance of oral hygiene, which are major advantages for many patients, particularly adults.[16] In clear aligner therapy, the forces delivered by aligners are generally perceived to be lighter and more intermittent, particularly because the magnitude of force decays over the wear period of each aligner. These benefits have led to a widespread belief that clear aligners are less painful than fixed appliances.[17] Several systematic reviews and meta-analyses have supported this belief, revealing lower pain scores and higher initial oral-health-related quality of life (OHRQoL) for patients with aligners.[18–20] Several studies have indicated that although the nature of discomfort may differ (eg, pressure pain vs. sharp pain from brackets), aligners are not entirely pain-free and can still affect quality of life (QoL).[21,22]

Although patient-reported outcomes have attracted major attention in the Taiwanese orthodontic community, local research has predominantly focused on specific dyads, such as comparisons of 2 types of fixed appliances, or on posttreatment satisfaction rather than on the initial adaptation phase. For instance, multiple studies have compared the levels of pain associated with traditional and self-ligating brackets or assessed OHRQoL changes in patients with clear aligners as a single cohort.[32] By contrast, few studies have conducted direct, prospective, or multidimensional comparisons of the 3 most commonly used

appliances in the local adult population in Taiwan. Furthermore, detailed analyses of how these different modalities influence the specific subdomains of OHRQoL remain largely unexplored in the context of Taiwan. This scarcity of local comparative data hinders the ability of clinicians in Taiwan to provide culturally and demographically relevant counseling to their patients. Overall, the innovation of the present study lies in its 3-fold approach: (1) the simultaneous, prospective comparison of the 3 most common orthodontic modalities in a real-world clinical setting; (2) the use of a multidimensional assessment tool that combines pain, anxiety, and a detailed 7-domain analysis of OHRQoL; and (3) the application of a longitudinal design to map the trajectory of adaptation during the most crucial initial phase of treatment. This comprehensive approach aims to fill the aforementioned research gap and provide a more comprehensive overview of patient experiences.

In this study, our primary goal was to provide comprehensive evidence-based data to inform the shared decision-making process between clinicians and patients by prospectively comparing the effects of 3 types of appliances.[23] Our specific goals were to (1) describe and compare the trajectories of pain, anxiety, and OHRQoL across the 3 groups over the first month of treatment and (2) determine whether the changes observed in these outcomes, including the 7 subdomains of the 14-item Oral Health Impact Profile (OHIP-14), significantly differed by appliance type. We formally tested the following hypotheses: Primary hypothesis: The longitudinal trajectories of pain and overall OHRQoL significantly differ among the 3 groups, with the clear aligner group exhibiting the most favorable outcomes. Secondary hypothesis: The primary differences in OHRQoL are concentrated in the "functional limitation" and "physical pain" subdomains, and no significant difference exists in the trajectory of anxiety, suggesting that it is a universal factor independent of appliance type.

Materials and methods

Study design and participants

A prospective, nonrandomized, parallel-group comparative design was selected because it reflects real-world clinical practice in which the choice of orthodontic appliance is often a shared decision between the clinician and the patient, depending on clinical requirements, esthetic preferences, and financial considerations. Although randomization is the gold standard for minimizing selection bias, our approach enhances the external validity of the findings to typical clinical settings. We statistically controlled for potential confounding factors by ensuring and verifying baseline comparability among the groups on key demographic and clinical variables. Patients aged $\geq$18 years were consecutively recruited from several dental clinics in the metropolitan area of Kaohsiung, Taiwan, between August 2023 and June 2025. Patients were divided into 3 groups on the basis of treatment modality: (1) traditional fixed appliances (metal brackets with elastomeric ligatures), (2) self-ligating fixed appliances, and (3) clear aligners (Invisalign). Patients in the clear aligner group were instructed to wear their aligners for 20 to 22 h *per* day, removing them only for eating and oral hygiene. Patients were included if they were aged $\geq$18 years, were scheduled for first-time comprehensive fixed orthodontic therapy in both arches, and had good general and oral health. Patients were excluded if they required surgical or complex multidisciplinary treatment, had any active temporomandibular disorder or severe periodontal disease, or regularly used medications that may confound pain or anxiety assessment.

To ensure the comparability of clinical case complexity across the 3 nonrandomized groups, the initial severity of malocclusion for all potential participants was assessed. This assessment was conducted by 2 experienced orthodontists using the Peer Assessment Rating (PAR) index, which is based on pretreatment dental casts and radiographic records.[31] The PAR index provides a quantitative score for the degree of occlusal deviation from the norm. To standardize the sample, only patients with moderate malocclusion severity, defined as a pretreatment PAR score between 25 and 40, were included in the final study cohort. This step was taken to minimize the potential confounding effect of initial case severity on patient-reported outcomes.

Ethical considerations

The study protocol was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (approval no. KMUHIRB-E(II)-20230166). The study was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent after being given information about the study objectives and procedures.

Data collection

Data were collected at 3 time points: T0 (baseline): before appliance placement, T1 (initial impact): 1 week (7 $\pm$ 1 days) after appliance placement, T2 (adaptation phase): 1 month (30 $\pm$ 3 days) after treatment initiation.

Measurement instruments

A combination of validated, widely used instruments were selected to comprehensively assess the patients' experiences.

Pain assessment

Pain intensity was measured using the 10-point visual analog scale (VAS). This scale was selected because of its simplicity, high sensitivity to change, and robust ratio scale properties. The VAS is considered the gold standard for assessing subjective pain because it enables patients to express their pain level on a continuous spectrum rather than being confined to categorical descriptors. This makes it particularly well suited for longitudinal studies aiming to capture subtle yet clinically meaningful changes in pain intensity over time.

Anxiety assessment

Anxiety was assessed using the 7-item generalized anxiety disorder (GAD-7) scale.[24] This scale was selected because it is a brief, efficient, and well-validated screening tool that is easy for patients to complete and for researchers to score. It also demonstrates excellent reliability and validity for assessing anxiety symptoms in both general and clinical populations, including in the Mandarin Chinese context.[25] Moreover, its focus on the frequency of symptoms observed over the "past 2 weeks" makes it an appropriate measure for capturing the patient's current psychological state because it relates to a specific phase of their treatment, from pretreatment anticipation to initial adaptation.

OHRQoL assessment

OHRQoL was assessed using the OHIP-14.[26] This instrument was selected because it is the most widely used and rigorously validated short-form measure of OHRQoL worldwide. Its primary advantage is its multidimensional nature. Instead of posing a single global question, the OHIP-14 assesses 7 distinct domains: functional limitations, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.[27] This structure facilitates a more nuanced and comprehensive understanding of how orthodontic treatment affects daily life activities. Separately analyzing these subdomains provides a more comprehensive insight into patients' experiences compared with total scores alone.[28]

Statistical analysis

Statistical analyses were designed to rigorously test the hypotheses through a multistage process. All analyses were conducted using IBM SPSS Statistics version 26.0 (IBM, Armonk, NY, USA), with significance set at $\alpha = 0.05$. To establish a credible basis for comparison, descriptive statistics were generated for all demographic and baseline clinical variables. One-way analysis of variance (ANOVA) was conducted to compare the means of continuous variables (age and baseline scores) across the 3 groups, followed by a chi-square test for the categorical variable (gender). The goal of this initial step was to confirm the absence of preexisting significant differences between the groups before the intervention.

In our hypothesis testing procedure, we primarily relied on generalized estimating equations (GEEs).[29] This advanced statistical approach was selected over traditional repeated-measures ANOVA for several reasons. GEE analysis is particularly well suited for longitudinal data because it effectively accounts for the correlation between repeated measurements from the same participant over time, thereby providing more robust and accurate estimates. GEE analysis is also less restrictive than repeated-measures ANOVA in its assumptions regarding the distribution of data.[30] To directly test our primary and secondary hypotheses, we constructed separate GEE models for each outcome variable (VAS, GAD-7, OHIP-14 total score, and each of the 7 subdomains of the OHIP-14). The key element in these models was the inclusion of a time and appliance type interaction term. This term directly assessed whether the change in an outcome over the 3 time points (trajectory) was statistically different among the traditional, self-ligating, and Invisalign groups. A significant *P* value for this interaction term would provide evidence supporting our hypothesis that patients' experiences are dependent on appliance type. Conversely, a nonsignificant *P* value would suggest a similar experience across groups. In the present study, an exchangeable working correlation structure was selected, and all models were statistically adjusted for age and gender to control for their potential confounding effects. Fig. 1 presents a summary of the study design and data flow.

Results

Participant characteristics and baseline comparison

A total of 97 adult patients with complete data from T0, T1, and T2 were included in the final analysis. Initially, 102 patients were recruited; however, 5 patients were excluded from the final analysis due to incomplete survey

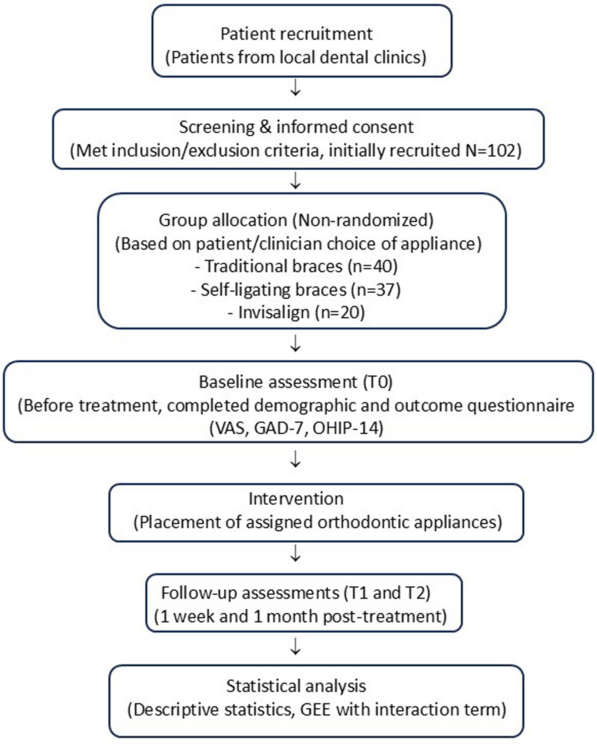

Figure 1 Research study flowchart. This figure visually outlines the steps from patient recruitment through screening, group allocation based on appliance choice, baseline assessment (T0), intervention (appliance placement), follow-up assessments at one week (T1) and one month (T2), data compilation excluding ineligible participants, and the final statistical analysis using GEE with interaction terms. VAS: visual analog scale, GAD-7: 7-item generalized anxiety disorder scale, OHIP-14: oral health impact profile-14, GEE: generalized estimating equation.

responses at the T1 or T2 follow-up, resulting in a final sample size of 97. Patients were divided into a traditional braces group ($n = 40$), a self-ligating braces group ($n = 37$), and an Invisalign group ($n = 20$). All 3 groups were well matched at baseline (Table 1). No significant between-group differences were observed in mean age; gender distribution; or initial patient-reported scores for pain, anxiety, or overall OHRQoL ($P > 0.05$ for all comparisons). This initial homogeneity provided a solid foundation for attributing any subsequently observed differences in outcomes to different appliance types.

Longitudinal comparison of primary patient-reported outcomes

Changes over time were analyzed using generalized estimating equations (GEE) to account for within-subject correlations and to compare temporal trends among treatment groups, confirmed that the trajectories of pain and OHRQoL but not anxiety significantly differed across the groups. The specific changes are detailed in Table 2.

Pain (VAS): Analysis of pain revealed a significant interaction effect ($P = 0.031$), confirming the primary hypothesis that pain perception over time is dependent on the type of appliance used. All 3 groups experienced a sharp increase in pain at T1. This increase was most pronounced in the fixed appliance groups, in whom the mean VAS scores indicated moderate pain (traditional braces group: 5.20; self-ligating braces group: 4.85). The Invisalign group reported significantly less pain, with a mean score of only 2.95. By T2, the levels of pain in all 3 groups had considerably subsided, returning to levels statistically indistinguishable from those at T0.

Anxiety (GAD-7): The trajectory of anxiety exhibited a distinct pattern. Changes over time and appliance type interaction was not significant ($P = 0.852$), thereby rejecting the hypothesis of a differential effect and indicating a universal psychological response. All 3 groups reported their highest anxiety levels at T0, before the initiation of treatment. After the placement of appliances, anxiety scores significantly and progressively decreased at both T1 and T2 for all groups, regardless of the appliance used.

OHRQoL (OHIP-14 total score): The effect of appliance type on QoL substantially differed by group. The interaction effect was significant ($P < 0.001$). This finding confirmed that appliance type had a profound effect on patients' daily life during the initial adaptation phase. At T1, the fixed appliance groups experienced a severe reduction in OHRQoL, with their mean OHIP-14 scores reaching 19.80 (traditional braces group) and 18.50 (self-ligating braces group). The Invisalign group experienced a smaller reduction in OHRQoL, with a mean score of 12.30. By T2, all groups had demonstrated remarkable recovery, with scores returning to their baseline levels or better.

Subdomain analysis of OHRQoL

To further investigate the nature of OHRQoL changes, GEE analysis was performed Table 3. This analysis confirmed our secondary hypothesis, revealing that the significant overall OHRQoL differences observed were almost entirely driven by 2 specific domains.

Significant domains (functional limitations and physical pain): GEE analysis revealed highly significant time and appliance type interaction effects for functional limitations ($P < 0.001$) and physical pain ($P < 0.001$). At T1, the scores for these domains more than doubled for the fixed appliance groups, indicating significant difficulties with activities such as eating and speaking and with experiences of jaw pain and oral soreness. By contrast, scores in these domains in the Invisalign group increased only modestly, highlighting a clear advantage in preserving functional ability and minimizing physical pain during the first week.

Nonsignificant domains (psychosocial aspects): For the remaining 5 subdomains (psychological discomfort, physical disability, psychological disability, social disability, and handicap), which primarily capture psychosocial experiences, the interaction effects were not significant ($P > 0.05$ for all). This result indicated that although all patients in all groups experienced a slight increase in psychosocial distress at T1, the magnitude of this effect did not differ with the type of appliance used.

Table 1 Baseline demographics and clinical scores by appliance type (n = 97).

Characteristic	Traditional braces (n = 40) Mean ± SD	Self-ligating braces (n = 37) Mean ± SD	Invisalign (n = 20) Mean ± SD	*P*-value
Age (years)	29.10 ± 10.15	28.51 ± 9.80	28.15 ± 9.75	0.931[a]
Gender, n (%)				0.975[b]
Female	26 (65.0 %)	24 (64.9 %)	13 (65.0 %)	
Male	14 (35.0 %)	13 (35.1 %)	7 (35.0 %)	
Pain (VAS)	1.05 ± 2.15	0.95 ± 2.01	1.15 ± 2.20	0.945[a]
Anxiety (GAD-7)	5.10 ± 4.25	4.80 ± 4.10	4.90 ± 4.28	0.918[a]
OHRQoL (OHIP-14)	8.10 ± 7.75	7.85 ± 7.60	8.05 ± 7.80	0.987[a]

VAS: visual analog scale, GAD-7: 7-item generalized anxiety disorder scale.
OHRQoL: oral health-related quality of life, OHIP-14: oral health impact profile-14.
[a] *P*-value from one-way ANOVA.
[b] *P*-value from Chi-square test.

Table 2 Comparison of main outcomes across different appliance types over time.

Outcome variable	Time point	Traditional braces (Mean ± SD)	Self-ligating braces (Mean ± SD)	Invisalign (Mean ± SD)	Interaction *P*-value*
Pain (VAS)	T0 (baseline)	1.05 ± 2.15	0.95 ± 2.01	1.15 ± 2.20	0.031
	T1 (1 week)	5.20 ± 2.18	4.85 ± 2.30	2.95 ± 1.98	
	T2 (1 month)	0.55 ± 1.23	0.40 ± 1.15	0.25 ± 0.85	
Anxiety (GAD-7)	T0 (baseline)	5.10 ± 4.25	4.80 ± 4.10	4.90 ± 4.28	0.852
	T1 (1 week)	2.40 ± 2.85	2.20 ± 2.75	2.50 ± 2.95	
	T2 (1 month)	1.40 ± 2.10	1.25 ± 1.95	1.45 ± 2.25	
OHRQoL (OHIP-14)	T0 (baseline)	8.10 ± 7.75	7.85 ± 7.60	8.05 ± 7.80	<0.001
	T1 (1 week)	19.80 ± 6.20	18.50 ± 5.95	12.30 ± 5.10	
	T2 (1 month)	6.30 ± 5.15	6.05 ± 4.90	4.50 ± 4.20	

**P*-value for the time and appliance type interaction effect from the GEE model, adjusted for age and gender.
VAS: visual analog scale, GAD-7: 7-item generalized anxiety disorder scale.
OHRQoL: oral health-related quality of life, OHIP-14: oral health impact profile-14.

Table 3 Comparison of OHIP-14 subdomain scores across different appliance types over time.

OHRQoL Subdomain	Time	Traditional braces (Mean ± SD)	Self-ligating braces (Mean ± SD)	Invisalign (Mean ± SD)	Interaction *P*-value
Functional limitation	T0	1.80 ± 2.11	1.75 ± 2.05	1.85 ± 2.15	<0.001
	T1	5.10 ± 1.85	4.80 ± 1.75	2.20 ± 1.30	
	T2	1.20 ± 1.45	1.15 ± 1.35	0.80 ± 1.10	
Physical pain	T0	1.95 ± 2.25	1.90 ± 2.20	2.00 ± 2.30	<0.001
	T1	5.90 ± 1.95	5.60 ± 1.85	3.10 ± 1.55	
	T2	1.45 ± 1.60	1.40 ± 1.55	0.95 ± 1.25	
Psychological discomfort	T0	1.35 ± 1.85	1.30 ± 1.80	1.30 ± 1.90	<0.001
	T1	2.95 ± 1.90	2.80 ± 1.85	2.45 ± 1.70	
	T2	1.10 ± 1.40	1.05 ± 1.30	0.90 ± 1.20	
Physical disability	T0	1.05 ± 1.70	1.00 ± 1.65	1.05 ± 1.75	<0.001
	T1	2.60 ± 1.80	2.45 ± 1.70	1.90 ± 1.50	
	T2	0.90 ± 1.25	0.85 ± 1.15	0.70 ± 1.05	
Psychological disability	T0	0.75 ± 1.45	0.70 ± 1.40	0.70 ± 1.50	<0.001
	T1	1.40 ± 1.60	1.30 ± 1.55	1.15 ± 1.45	
	T2	0.65 ± 1.10	0.60 ± 1.00	0.50 ± 0.95	
Social disability	T0	0.65 ± 1.35	0.60 ± 1.30	0.65 ± 1.40	<0.001
	T1	1.05 ± 1.50	0.95 ± 1.40	0.85 ± 1.35	
	T2	0.55 ± 1.05	0.50 ± 0.95	0.40 ± 0.90	
Handicap	T0	0.55 ± 1.25	0.50 ± 1.20	0.55 ± 1.30	0.903
	T1	0.75 ± 1.30	0.70 ± 1.25	0.65 ± 1.20	
	T2	0.45 ± 0.95	0.40 ± 0.85	0.35 ± 0.80	

**P*-value for the time and appliance type interaction effect from the GEE model, adjusted for age and gender.
OHRQoL: oral health-related quality of life, OHIP-14: oral health impact profile-14.

Discussion

This study compared initial patient experiences after application of 3 different orthodontic appliances. By utilizing a longitudinal design and a robust GEE analysis with interaction terms, we demonstrated that the choice of appliance has a significant and measurable effect on patient-reported pain and QoL, particularly during the first week of treatment. Overall, our findings directly address our hypotheses and offer a comprehensive perspective supporting a more patient-centered approach in orthodontics.

A key finding of this study is the significant interaction effect between time and appliance type for pain and OHRQoL, which confirms our primary hypothesis. Our findings indicate that the physical journey of patients during the first month is not uniform across different treatment modalities.[32,33] As predicted, clear aligners offered a comfortable initial experience. At T1, the Invisalign group reported mean pain scores that were approximately 40 %

lower than those of the fixed appliance groups. This difference is not only statistically significant but also clinically meaningful, likely exceeding the threshold for what a patient perceives as a noticeable difference in comfort.[35] This finding is consistent with those of several studies and systematic reviews that have attributed lower pain levels to the nature of the forces applied by aligners—often described as lighter, more intermittent, and applied over the entire tooth surface through a thermoplastic material.[15,16,19] In the context of fixed appliances, the concentrated forces from the brackets and wires likely lead to a more intense initial inflammatory response in the periodontal ligament.[8]

Further analysis of the OHIP-14 subdomains provided a deeper understanding of the aforementioned difference and supported our secondary hypothesis. Notably, the superiority of clear aligners was not uniform across all aspects of QoL. Instead, it was concentrated in the domains of functional limitations and physical pain. This is a key insight, particularly because the ability to remove aligners for eating and cleaning directly mitigates the most common complaints associated with fixed appliances, which are difficulty chewing, problems with food impaction, and challenges in maintaining oral hygiene.[37] These findings directly explain the smaller increase in the functional limitation score for the Invisalign group. Similarly, the lower physical pain score likely reflects both reduced overall pain (as measured by the VAS) and reduced soft-tissue irritation from brackets and wires, a common complaint among patients with traditional appliances.[38] This domain-specific finding extends beyond a simple "less pain" conclusion, offering a more comprehensive overview of a "less disruptive" experience, which is a key component of the whole-person care model mentioned in the Introduction.

In this study, the effect of clear aligners on the psychological and social domains was comparable across groups. This suggests that although clear aligners can significantly reduce the physical burden of treatment, the broader psychological adjustments required, such as getting used to a new routine, dealing with speech changes, or feeling self-conscious about treatment, may be a more universal aspect of the orthodontic experience. This finding supports our secondary hypothesis that the trajectory of anxiety would be similar across all groups. Notably, the nonsignificant interaction for anxiety suggested that anticipatory anxiety was high for all patients, and the initiation of any type of treatment helped alleviate it by resolving "fear of the unknown."[34] To fit this context, the GAD-7 was specifically used to measure anxiety, instead of a more specific dental anxiety scale. Orthodontic treatment is a major life event with social and financial implications. The GAD-7 captures this type of broad, generalized anxiety. Overall, our findings suggest that this overarching psychological adaptation process is largely independent of the specific hardware used. Appliance type affects the physical experience, but the decision to commit to treatment is the primary psychological barrier for all patients.[39]

This study contributes to the ongoing debate regarding the benefits of self-ligating versus traditional braces. Our data revealed no significant difference in pain, overall OHRQoL, or any of the specific OHRQoL domains between the fixed appliance groups, whose trajectories were almost identical. These results confirm those of studies indicating no significant patient-centered advantage for self-ligating systems during the initial treatment phase.[11,12,21] This strengthens the argument that from a patient-experience perspective, the fundamental design of fixed appliances (ie, brackets and wires) is the primary driver of initial discomfort, more so than the specific method of ligation. This finding reinforces the conclusion of several systematic reviews reporting insufficient evidence to claim the superiority of a fixed bracket system over another in terms of patient comfort.[40]

In the context of whole-person care,[36] our two findings have direct implications for evidence-based practice. Clinicians can move beyond general statements regarding patient comfort. For patients selecting fixed appliances, specific warnings can be provided regarding expected difficulties with eating and an increased likelihood of oral pain. For patients selecting Invisalign, counseling can focus more on the routine of removal or insertion and speech adaptation.

Our findings can be used to enhance shared decision-making.[23] Clinicians can now provide their patients with clear, comparative data on how each appliance may affect their physical and functional well-being. This approach can help patients make choices that align with their lifestyles and priorities.

This study has several limitations. First, patients were nonrandomly allocated to treatment groups; this may have introduced selection bias. Patients who selected Invisalign may have differed in unmeasured aspects (eg, motivation and socioeconomic status) from those who selected fixed braces.[25] Nevertheless, our finding of no significant between-group differences at baseline in key demographic or clinical variables mitigates this concern. Second, the Invisalign group ($n = 20$) was smaller than the fixed appliance groups ($n = 40$ and $n = 37$). While the GEE analysis is robust for handling unbalanced designs, this sample size imbalance may have reduced the statistical power to detect smaller, more subtle differences between the aligner and fixed appliance groups. Further multicenter studies with larger and more balanced cohorts are required. Third, the follow-up period of 1 month, despite being appropriate for the initial adaptation phase, was not sufficient to capture long-term experiences, including discomfort from subsequent adjustments or aligner changes. Fourth, compliance in the Invisalign group was self-reported and not objectively monitored; although patients reported adequate adherence during this initial phase, the lack of objective tracking data is a potential limitation.

In summary, the choice of orthodontic appliance has a significant and domain-specific differential effect on patients' experiences. Compared with traditional and self-ligating fixed appliances, clear aligners are associated with a more comfortable initial adaptation period, driven primarily by significantly fewer functional limitations and lower levels of physical pain. These findings can help clinicians better formulate patient-centered decisions and establish realistic expectations for orthodontic treatment. By shifting the focus from the teeth to the patient's overall experience, this study reinforces the importance of the patient's overall quality of life as a key consideration in orthodontic treatment planning.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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