GRADUATION PROJECT

Degree in Dentistry

DISCOMFORT AND PAIN PERCEPTION IN ORTHODONTIC PATIENTS WITH ALIGNERS VS FIXED ORTHODONTICS

Madrid, academic year 2024/2025

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RESUMEN

Introducción: Los tratamientos ortodóncicos implican distintos niveles de dolor e incomodidad, lo que puede afectar la calidad de vida del paciente, su adherencia y satisfacción con el tratamiento. Mientras los aparatos fijos como los brackets han sido el método tradicional, los alineadores transparentes han ganado popularidad por su mayor comodidad percibida. Comprender las diferencias en la percepción del dolor entre ambos es clave para una atención centrada en el paciente. **Objetivos:** (1) Evaluar la percepción del dolor e incomodidad en pacientes tratados con aparatos fijos frente a alineadores transparentes (2) Comparar cómo la intensidad y duración del dolor afectan la calidad de vida relacionada con la salud bucal (OHRQoL) en ambos grupos. **Materiales y métodos:**
Se realizó una revisión de doce estudios científicos comparando niveles de dolor, duración de la incomodidad y OHRQoL entre ambos tratamientos. Se analizaron la intensidad del dolor (medida con escalas visuales analógicas), el consumo de analgésicos, las limitaciones funcionales y el impacto psicológico. **Resultados:** Los pacientes con alineadores transparentes experimentaron menos dolor, especialmente al inicio del tratamiento. El dolor fue más leve y breve, con menor impacto funcional. Además, reportaron mejores resultados en OHRQoL, mayor comodidad al comer y hablar, menos ansiedad y mayor satisfacción. En cambio, los aparatos fijos se asociaron con más incomodidad y dolor prolongado. **Conclusiones:** Los alineadores transparentes ofrecen una experiencia más cómoda y mejoran la calidad de vida del paciente, destacando la importancia de considerar su bienestar en la planificación ortodóncica.

PALABRAS CLAVE

Odontología, Ortodoncia, Percepción del dolor, Alineadores transparentes, Aparatos fijos

ABSTRACT

Introduction: Orthodontic treatments often cause varying levels of pain and discomfort, impacting patients' quality of life, compliance, and satisfaction. Fixed appliances like brackets and wires have been the standard, but clear aligners are increasingly popular due to their perceived comfort. Understanding pain perception differences between these treatments is essential for patient-centered care. **Objectives:** (1) To assess pain and discomfort perception in patients treated with fixed appliances versus clear aligners (2) To compare how pain intensity and duration affect oral health-related quality of life (OHRQoL) in both groups. **Material and methods:** A literature review was conducted using twelve peer-reviewed studies comparing pain levels, discomfort duration, and OHRQoL between fixed appliances and clear aligners. Parameters analyzed included pain intensity (via visual analogue scales), analgesic use, functional limitations, and psychological impact. **Results:** Patients with clear aligners consistently reported less pain, especially in the initial phase. Pain was milder, shorter in duration, and caused fewer daily limitations. Aligners were also associated with better OHRQoL outcomes—greater comfort while eating and speaking, lower anxiety, and higher satisfaction. In contrast, fixed appliances were linked to more prolonged discomfort and greater interference with daily life. **Conclusions:** Clear aligners provide a more comfortable orthodontic experience, with reduced pain and improved quality of life. These results emphasize the importance of including patient comfort and preferences in treatment planning, especially for those sensitive to pain or anxiety.

KEYWORDS

Dentistry, Orthodontics, Pain perception, Clear aligners, Fixed appliances

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1. INTRODUCTION

1.1. Orthodontics overview

Orthodontics is a branch of dentistry dedicated to the diagnosis, prevention, and treatment of dental and facial/skeletal irregularities that addresses issues such as malocclusions (misaligned teeth and jaws), crowding, spacing, and bite dysfunctions, which can have various functional, aesthetic and, therefore, psychological repercussions on patients[1]. Correcting these malocclusions is essential not only for achieving a symmetrical, attractive smile but also for optimizing oral health[2]. Correctly aligned teeth contribute to a more efficient occlusion, facilitate speech and mastication, and reduce the risk of trauma or wear to the teeth and joints over time[3]. In addition, a functional alignment simplifies proper cleaning, which can significantly decrease the likelihood of dental caries and periodontal disease[4]. Orthodontics also plays a role in managing the growth and development of the jaws, particularly in younger patients, where early intervention can prevent even more serious malocclusion problems later[1]. The orthodontic field combines clinical skills, aesthetic attention, and patient-centered care to improve the overall quality of life[2,3].

1.1.1. Biology of tooth movement

The biomechanical method used to achieve orthodontic tooth movement takes advantage of the body's innate ability to rebuild bone[1]. A dynamic process known as "bone remodeling" is created when teeth are subjected to regulated force, which causes a reaction in the alveolar bone and surrounding periodontal ligament[1]. The biological process of the bone reshaping is led by osteoclast activity (breakdown of bone on the tooth's pressure side) and osteoblast activity (creation of new bone on the tension side [5]. When combined, these exercises allow the teeth to migrate gradually and deliberately into the appropriate locations[1].

Despite their great effectiveness, orthodontic treatments can cause discomfort, particularly in the first 24 to 72 hours following adjustments[6]. Tooth movement frequently causes modest inflammation in the periodontal ligament, which in turn stimulates sensory neurons and can cause variable degrees of discomfort or sensitivity[5,6]. The degree of discomfort can vary depending on several factors, including the type of orthodontic device being used, force magnitude, and personal pain tolerance[6]. Although this feeling normally goes away as the mouth adjusts, pain management is still crucial, and professionals frequently suggest over-the-counter painkillers or orthodontic wax to reduce irritation of the soft tissues[5,6].

1.1.2. Evolution of orthodontic treatments

Over centuries, orthodontics has changed significantly, evolving from basic mechanical devices to advanced systems that intend to enhance clinical results and patient comfort while maintaining clinical outcomes[7]. Early teeth-alignment techniques, (which date back to ancient Egypt), applied pressure on teeth using crude materials like catgut cords[7]. The foundation for contemporary braces was laid by Pierre Fauchard, who is frequently regarded as the founder of modern dentistry and introduced metal bands to realign teeth in the 18th century (**Figure 1**).

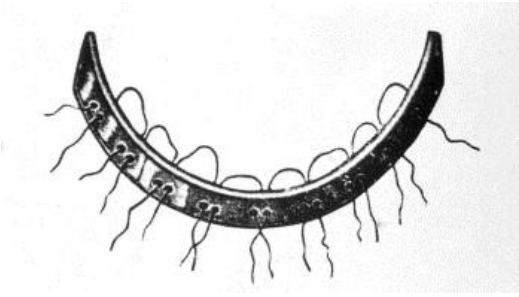

Figure 1. Fauchard's bandeau [7]

The invention of stainless steel brackets in the 20th century marked a significant breakthrough in orthodontics and made treatment results more consistent and long-lasting[8]. Orthodontists were able to carefully control tooth movement in numerous directions because of techniques like Edward Angle's "edgewise appliance," which revolutionized the treatment of malocclusions by controlling precisely tooth movement in multiple directions[8]. Advances in materials elections, self-ligating brackets, and lingual braces significantly expanded treatment possibilities, meeting a range of clinical requirements and enhancing patient comfort[8]. The development of clear aligners in the late 1990s has been one of the most revolutionary introductions in the orthodontics field in recent decades[9]. These aligners come as sequential custom trays, which are produced to order from medical-grade thermoplastics. Additionally, digital treatment planning in orthodontics has significantly improved accuracy, predictability, and patient satisfaction through the use of 3D imaging and computer-aided design (CAD) technology, paving the way for a more individualized and easily accessible approach to care[10].

1.1.3. Increasing demand for aesthetic solutions in the orthodontics field

Aesthetic concerns have grown in priority in the last decades as an important factor in orthodontic treatment decisions, especially for adults seeking treatment[11-12]. Aligners provide a more discrete alternative that blends in well with adult lifestyles in comparison with traditional braces, which are frequently associated with adolescence[11]. Because of their "invisible" look and compatibility with various diary activities, transparent aligners have become a popular option for patients who are increasingly concerned about comfort and appearance[11-13]. Beyond only being aesthetically pleasing, aligners are also removable, which gives them a significant flexibility benefit over conventional braces[11]. Patients may continue to maintain oral hygiene by brushing and flossing more simply without having to deal with brackets and wires, and they can still consume the things they love without any limitations[13]. The population tends to value more the freedom to participate in social or professional activities without worrying about obvious orthodontic gear and have taken a strong interest in this flexibility[12]. According to studies, aligners may cause less soft-tissue irritation in patients than traditional braces, which adds to their physical appealing[13]. A larger trend toward individual attention, where patients look for solutions that fit their unique goals and lifestyles, is reflected in the demand for clear aligners[11,12]. This change has initiated improvements in aligner technology, such as enhancements in manufacturing processes, materials, and even artificial intelligence algorithms that assist in customizing treatment to each patient's particular dental structure[11]. When taken as a whole, these developments are reshaping orthodontics to emphasize patient-centered outcomes, comfort, and aesthetics[11,12].

1.2. Overview of fixed orthodontic appliances

Fixed orthodontic appliances, commonly referred to as traditional braces, are one of the most widely utilized methods of orthodontic treatment for the correction of dental malocclusions this is why they are typically recommended for patients with complex cases that cannot be managed effectively with removable aligners[14]. Fixed appliances are composed of brackets that are bonded directly to the teeth, connected by arch wires, and often supplemented with elastics or springs for further correction of the bite[14]. These appliances work continuously, providing a steady force over time to gradually move the teeth into the desired position[14].

1.2.1. Description and mechanism

The core components of fixed orthodontic appliances include brackets, arch wires, and elastics, each of which plays a key role in the mechanics of tooth movement[14].

A. **Brackets:** These are small devices that are bonded to the facial or lingual surface of each tooth[14]. They come in various materials, such as stainless steel, ceramic, or plastic, each with different aesthetic or strength properties[14]. Brackets are designed to hold the arch wire while applying force to the tooth, initiating its movement and they are usually attached to the teeth with a special adhesive or bonding agent, which ensures they remain securely in place for the duration of treatment[14].

B. **Arch wires:** These are thin, flexible wires that connect the brackets and are responsible for most of the tooth movement[14]. Arch wires come in a variety of metals, including stainless steel, nickel-titanium, and beta-titanium, each offering different levels of flexibility and strength[14]. The arch wire is threaded through the slots of the brackets and is adjusted periodically by the orthodontist to apply continuous force to the teeth that will gradually move the teeth into alignment[14].

C. **Elastics and auxiliary devices:** In many cases, elastics (rubber bands) or other auxiliary devices such as springs, coils, and separators are used in conjunction with fixed appliances to address specific orthodontic issues[14]. Elastics are typically used to correct bite problems, such as overbites, underbites, or crossbites, by applying force to the upper and lower jaws to reposition them[8,14]. Springs and coils may be added to provide additional space between teeth or to address issues like tooth rotation or tooth alignment[14].

The mechanism of tooth movement is primarily based on the application of continuous, gradual, and gentle pressure through the arch wire that will be later on transferred to the tooth's periodontal ligament, the tissue that surrounds the root of the tooth[5,6]. The force causes the bone surrounding the tooth to break down and remodel, allowing the tooth to move. Over time, the tissue on the opposite side of the tooth remodels to support its new position[5,6].

1.2.2. Prevalence and effectiveness

Fixed orthodontic appliances remain the gold standard in orthodontics due to their clinical effectiveness and ability to manage a wide range of malocclusions[15,16]. According to recent studies, over 70% of orthodontic patients worldwide are treated with traditional braces, particularly for complex cases where removable aligners might be less effective[15]. This includes cases of severe crowding, large overbites or underbites, open bites, and other significant dental and skeletal issues that require a high level of control over tooth movement[16].

One of the primary advantages of fixed appliances is the level of precision they offer in moving teeth[16]. The brackets and arch wires are custom-designed for each patient, allowing for highly controlled adjustments that are difficult to achieve with removable aligners, especially in more complex cases[11,12,16]. Fixed appliances are also ideal for addressing the needs of growing children and adolescents, as they can modify both dental and skeletal structures throughout treatment[17]. Furthermore, fixed appliances are generally more cost-effective than clear aligners, especially for patients with complex malocclusions[16,17].

1.2.3. Challenges and discomfort

Despite their effectiveness, fixed orthodontic appliances are associated with several inconveniences, indeed, patients commonly experience pain and tenderness after wire adjustments, which may last several days as teeth and supporting structures respond to the new pressures[18]. Additionally, the brackets and wires can irritate the soft tissues of the mouth, leading to sore spots on the cheeks and lips[18]. Some patients even refer frustrations when it comes to alimentation since they can't freely eat any kind of nutriment, as hard or sticky food should be avoided to improve the prognosis of the treatment[18]. Another challenge posed by fixed appliances is the difficulty in maintaining optimal oral hygiene; food particles and plaque tend to accumulate around the brackets and wires, increasing the risk of cavities and gum inflammation if not carefully managed[19]. These challenges can impact patients' comfort and motivation, making effective pain management and hygiene guidance essential aspects of treatment [18,19].

1.3. Introduction to Clear Aligners

Clear aligners are among the most modern orthodontic treatment methods designed to treat various types of malocclusions and improve dental alignment in a discreet, comfortable, and flexible way[11-13]. Since their introduction in the late 1990s, these trays have become incredibly popular due to their aesthetic and convenience characteristics compared to fixed conventional appliances[9,11,12]. They are usually manufactured using digital scanners and advanced 3-dimensional printing technologies[9,10]. Each patient receives a sequence of custom-made transparent aligners that suit their individual needs, where each specific aligner is designed to apply light, controlled forces to guide the teeth into the desired position[20]. Patients are typically advised to change trays every 1 to 2 weeks, and each new tray will allow progressive movement of around 0.2-0.33mm per tooth[20].

The removable nature of aligners enables patients to maintain normal oral hygiene, reducing the likelihood of plaque build-up and, therefore gingival inflammation that we commonly encounter with fixed braces[13]. However, although clear aligners are considered effective in a wide range of mild to moderate cases of crowding/spacing or non-complex malocclusion, some reports suggest that their use may be somehow limited in more complicated cases in comparison with fixed appliances[11,12,16].

1.3.1. Advantages over fixed appliances

Clear aligners present multiple benefits compared to fixed appliances, which has contributed to their quick global acceptance among numerous patients[11-13]. While the cosmetic criteria are commonly acknowledged, there are additional advantages that are less frequently considered but equally relevant[11-13]. Aligners are linked to a reduced risk of root resorption due to their ability to exert more controlled and gradual force[11]. Similarly, we can observe a lower incidence of enamel demineralization, as their removable design encourages improved oral hygiene[21]. Their detachable nature also enables patients to maintain a normal diet without restriction, which both prevents frustration and the risk of detachment that we encounter with fixed devices[11,21].

Aligners also represent a progress in treatment planning since they are fabricated using advanced computerized treatment planning systems; this ensures high precision and predictability and allows patients a preview of their expected treatment outcome[10]. Such

personalization ensures customized movements for each particular case and ameliorates the overall efficiency of the treatment[10].

They are also more comfortable than traditional braces with no brackets or wires that will irritate soft tissues, and their design minimizes orthodontic visit of emergencies due to broken components[13]. On average, treatment with aligners also needs fewer in-office chair time adjustments, thereby saving valuable time for both the patients and the practitioners[11].

1.3.2. Limitations of aligners compared to fixed appliances

Despite the advantages that the aligners offer, there remain many limitations that might make them unsuitable for certain orthodontic situations[13]. One of the most concerning matters is their reliance on patient compliance[20]. The good outcome of the treatment depends entirely on it, as the aligners must be worn at least 20 to 22 hours a day, at the risk, if not complied, to less accurate or slower tooth movement[20].

Fixed appliances by their components are stiffer, thus allowing more control and precision in the treatment of more complex orthodontic cases (extrusion, occlusion)[13,22]. Aligners are sometimes incapable of addressing skeletal issues, especially in growing patients, in whom fixed devices would be preferred[11,12,16]. To treat more complex cases, aligners often require supplemental attachments or elastic to achieve the desired tooth movement, adding treatment complexity and also reducing their esthetic and comfort values[20,22]. Although the removable nature provides a degree of flexibility, it also implies that the aligners could be lost or damaged, potentially resulting in delays or interruptions in the treatment process[11].

1.4. Pain and discomfort in orthodontic treatment

Orthodontic patients commonly report experiencing pain and discomfort, which is frequently mentioned as a major downside of orthodontic therapy[23]. The perception and tolerance of pain vary widely among individuals due to personal, psychological, and physiological factors[23,24]. Orthodontic pain usually arises from forces applied to teeth, which cause biological changes within periodontal structures and surrounding tissues, leading to an inflammatory response and associated discomfort[6]. Different orthodontic techniques, such as fixed appliances and clear aligners, vary in their biomechanical properties, influencing the type, intensity, and duration of pain experienced by patients[25].

1.4.1. Biological basis of pain

Orthodontic pain is primarily due to the mechanical forces applied to teeth, which initiate a series of biological responses involving periodontal ligament tissues and alveolar bone[6]. When orthodontic forces are applied, periodontal ligament tissues undergo compression and tension, triggering an inflammatory reaction characterized by increased vascular permeability, localized edema, and infiltration of inflammatory mediators such as prostaglandins, cytokines, and substance P[6]. These biochemical mediators stimulate nociceptive nerve endings, initiating the sensation of pain[6].

Typically, orthodontic pain begins within a few hours after appliance activation or adjustment, peaks around 24 to 48 hours, and gradually subsides within a week as inflammation decreases and tissues adapt[25]. Variability in pain sensitivity among individuals can be attributed to differences in biological factors, such as nerve density, individual pain thresholds, inflammatory response intensity, and psychological aspects, including anxiety and stress levels[23,24].

Moreover, factors such as the magnitude and type of orthodontic forces, appliance design (fixed brackets, self-ligating brackets, clear aligners), and the individual's biological response play crucial roles in determining the pain profile[25]. For example, continuous and gentle forces, often associated with clear aligners, may induce a lower inflammatory response compared to intermittent or more intense forces typically delivered by fixed appliances[26].

1.4.2. Impact on patients' quality of life

Pain and discomfort significantly influence patients' Oral Health-Related Quality of Life (OHRQoL), impacting physical, psychological, and social dimensions[24]. Orthodontic treatment, despite aiming to improve oral function and aesthetics, often has temporary adverse effects on various daily activities. Patients frequently report difficulties in mastication, altered speech, dietary restrictions, disrupted sleep, and psychological impacts such as stress, anxiety, and reduced self-esteem, particularly during the initial treatment stages[24].

Assessment of subjective parameters such as pain typically involves Visual Analogue Scale (VAS), which quantifies pain intensity in a way that is intuitive and easy for patients to understand (**Figure 2**).

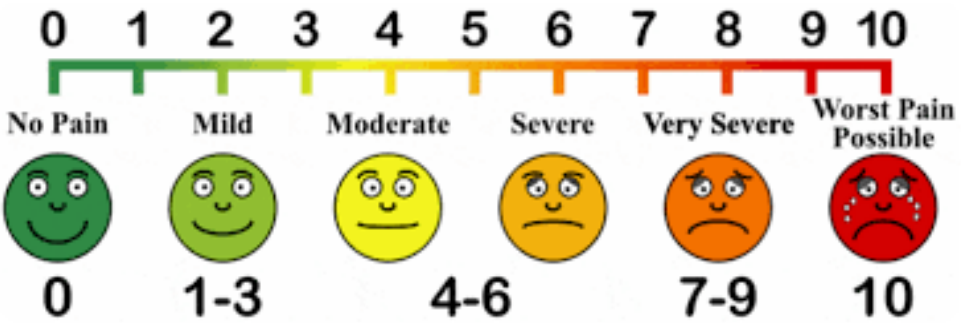

Figure 2. Visual Analogue Scale (VAS)

To estimate these different impacts on daily life and assess discomfort, self-reported questionnaires remain the most common due to their ability to capture subjective experiences directly from patients[27]. While these tools may vary in their structure and focus, they share a similar format; structured surveys where patients rate the frequency and severity of symptoms affecting their quality of life[27]. Among these instruments, the OHRQoL questionnaires have become the gold standard, offering both comprehensive and specific assessments of oral health-related well-being[24]. These questionnaires aim to evaluate the broader implications of orthodontic treatment on quality of life by measuring multiple dimensions of the patient's experience, including functional limitations (chewing, speaking), physical pain, psychological discomfort, physical disability, psychological disability, social interaction impairment, and overall life impacts[24].

The OHIP-14, a shorter version of the original OHIP-49, is particularly useful in orthodontic research due to its reliability, ease of administration, and ability to provide meaningful insights into how orthodontic treatment, including the use of fixed appliances and clear aligners, affects different aspects of daily life (**Figure 3**).

	Very Often	Fairly Often	Occas-ionally	Hardly ever	Never	Don't know
1. Have you had trouble pronouncing any words because of problems with your teeth or mouth?	○	○	○	○	○	○
2. Have you felt that your sense of taste has worsened because of problems with your teeth or mouth?	○	○	○	○	○	○
3. Have you had painful aching in your mouth?	○	○	○	○	○	○
4. Have you found it uncomfortable to eat any foods because of problems with your teeth or mouth?	○	○	○	○	○	○
5. Have you been self conscious because of your teeth or mouth?	○	○	○	○	○	○
6. Have you felt tense because of problems with your teeth or mouth?	○	○	○	○	○	○
7. Has your diet been unsatisfactory because of problems with your teeth or mouth?	○	○	○	○	○	○
8. Have you had to interrupt meals because of problems with your teeth or mouth?	○	○	○	○	○	○
9. Have you found it difficult to relax because of problems with your teeth or mouth?	○	○	○	○	○	○
10. Have you been a bit embarrassed because of problems with your teeth or mouth?	○	○	○	○	○	○
11. Have you been a bit irritable with other people because of problems with your teeth or mouth?	○	○	○	○	○	○
12. Have you had difficulty doing your usual jobs because of problems with your teeth or mouth?	○	○	○	○	○	○
13. Have you felt that life in general was less satisfying because of problems with your teeth or mouth?	○	○	○	○	○	○
14. Have you been totally unable to function because of problems with your teeth or mouth?	○	○	○	○	○	○

Figure 3. OHP-14 questionnaire.

Beyond OHIP-14, other scales such as the Child Perceptions Questionnaire (CPQ), the Oral Aesthetic Subjective Impact Scale (OASIS), and the Orthodontic-Specific Quality of Life Measure (OSQOL) are also employed, depending on the specific focus of a study[24]. However, OHIP-14 remains the most widely used due to its strong validation across different populations and treatment modalities[24].

By utilizing such tools, researchers and clinicians can quantify the impact of orthodontic pain and discomfort more effectively, allowing for comparisons between treatment modalities such as fixed appliances and clear aligners, ultimately guiding improvements in patient care and treatment planning[24].

1.5. Justification

As the orthodontic field is in perspective evolution, there is an increasing need to understand the pain and discomfort associated with the different options available in the market, particularly between fixed appliances and clear aligners. Despite the expanding popularity of clear aligners, there remains a lack of consensus about the comparative pain experienced between these two methods of treatment. This systematic review aims to assess the perception of pain and discomfort in orthodontic patients treated with fixed appliances versus clear aligners. Given that pain management is a key factor influencing patient satisfaction and treatment compliance, understanding these differences is crucial to improve patient care and enhance the overall treatment protocol. Additionally, as clear aligners become more widely adopted by both practitioners and patients, it is essential to evaluate their benefits and limitations compared to traditional methods that gather more studies. This work will contribute to the existing literature by reviewing the tools that help us evaluate and acknowledge pain and discomfort, a subjective perception that may differ between patients. This review aims to further guide orthodontic practices and patient management strategies.

2. OBJECTIVE

Primary objective

- To assess the perception of pain and discomfort in orthodontic patients using fixed appliances versus aligners.

Secondary objective

- To compare the impact of the intensity, and evolution of pain and discomfort on the overall oral health related quality of life, between fixed appliances and clear aligners.

3. MATERIAL AND METHODS

3.1. Research question

In patients undergoing an orthodontic treatment, do patients wearing aligners experience less pain and discomfort in comparison with those using fixed appliances?

3.2. Eligibility criteria

3.2.1. Inclusion criteria

- Studies published within the last 10 years (2014–2024) to ensure relevance to current clinical practices and diagnostic advancements.
- Randomized controlled trials (RCTs), cohort studies, cross-sectional studies or case-control studies that directly compare pain and discomfort between patients using fixed appliances (traditional braces) and clear aligners.
- Publications in English or French to ensure accurate understanding and interpretation of findings.
- Studies that present the different assessment tools of pain and discomfort perception (intensity, duration, and frequency) using validated pain scales, questionnaires, or patient reports.
- Studies that mention the oral health-related quality of life in orthodontic patients wearing either fixed appliances or aligners

3.2.2. Exclusion criteria

- Articles published more than 10 years ago, unless cited as foundational studies about traditional braces.
- Studies without English or French translations.
- Studies that involve experimental or non-standard orthodontic treatment.
- Studies that do not use validated pain measurement scales or subjective questionnaires to assess the pain and discomfort perception.
- Studies on patients with underlying conditions such as chronic pain disorders that affect pain perception.

3.3. Information sources

The online databases used for article selection are either accessible through the UEM CRAI Library, PubMed, Academic Search Ultimate, or Dentistry and Oral Sciences.

3.4. Research strategy

This study aims to compare pain perception, discomfort, and quality of life in orthodontic patients based on the type of appliance used. The population (P) consists of orthodontic patients undergoing treatment. The intervention (I) involves aligners or removable appliances, while the comparison (C) includes braces or fixed appliances. The outcome (O) focuses on patient-reported pain, discomfort, and overall quality of life.

To find relevant studies to rely on, we focused on this advanced query *" Orthodontic " AND (" aligners " OR " removable appliance" OR "clear aligner") AND (" braces " OR " fixed appliance " OR " traditional treatment ") AND (" pain " OR " discomfort " OR "quality of life")*

3.5. Data collection process

The data to be extracted from the selective articles will be:

- Title of the article and authors
- Year of publishing
- Type of study
- Sample size of the study
- Sample size of the aligner group
- Sample size of the fixed orthodontic appliances
- Scale or index used to compare the perception of pain and discomfort
- Results of the index in each group
- Conclusions of the studies

4. RESULTS

4.1. Data extraction and analysis

Systematized literature research was realized throughout several databases, leading to the identification of 157 articles. The sources used were Medline Complete, ClinicalTrials.gov, Academic Search Ultimate, Dentistry and Oral Sciences, and Dulce Chacon UEM.

First, we proceeded to remove the 74 duplicates, which reduced the number of total articles to 83. During the screening phase, 61 records were excluded based on predefined inclusion and exclusion criteria, leaving 22 reports for full-text retrieval. None of these reports were unretrievable. 10 reports were then excluded due to factors such as study design, incomplete data, or lack of relevance to the research objectives. Consequently, 12 studies met all eligibility criteria and were included in the final review.

The study selection process is visually represented through a PRISMA flowchart (Figure 4).

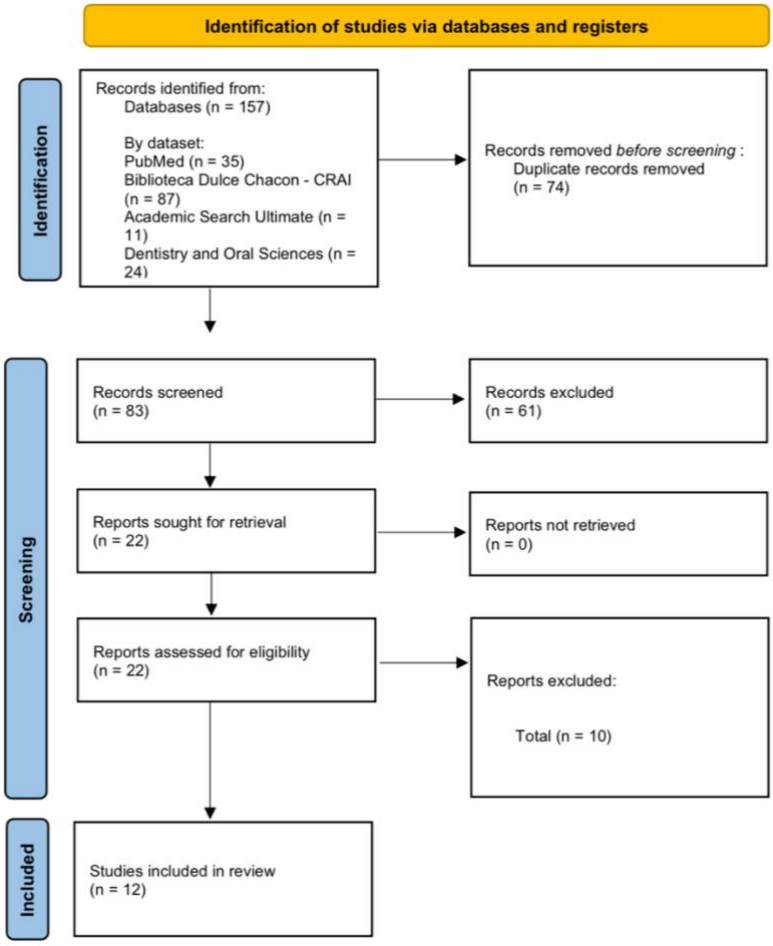

Figure 4. PRISMA flow chart

TITLE	YEAR	AUTHORS	TYPE OF STUDY	SAMPLE	COUNTRY
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 [28].	2024	Laura Correa et Al.	Longitudinal pilot study	80 patients	Spain
A randomized controlled trial of self-perceived pain, discomfort, and impairment of jaw function in children undergoing orthodontic treatment with fixed or removable appliances[29].	2016	Anna-Paulina Wiedel et Al.	Randomized controlled trial	62 patients	Sweden
Braces versus Invisalign® gingival parameters and patients' satisfaction during treatment: a cross-sectional study[30].	2015	A. Azaripour et Al.	Cross sectional study	100 patients	Germany
Comparison of short-term oral impacts experienced by patients treated with Invisalign or conventional fixed orthodontic appliances[31].	2019	Saitah Alajmi et Al.	Observational retrospective	60 patients	Kuwait
Discomfort associated with Invisalign and traditional brackets: A randomized, prospective trial [32].	2017	David W. White et Al.	Randomized prospective trial	41 patients	USA
Evaluation and comparative assessment of clear aligners and conventional appliances on oral health-related quality of life in pediatric populations: a cross-sectional study[33].	2024	Qi Wang & Al.	Cross-sectional study	427 patients	China
Evaluation of pain intensity in patients treated with aligners and conventional fixed appliances: A randomized clinical trial[34].	2020	Cleomária EVFC et Al	Randomized clinical trial	39 patients	Brazil
Oral Impacts Experienced by Orthodontic Patients Undergoing Fixed or Removable Appliances Therapy in Saudi Arabia: A Cross-Sectional Study[35].	2021	Mohammad AB et al.	Cross-sectionnal study	150 patients	Saudi Arabia
Orthodontic pain with fixed appliances and clear aligners: A 6-month comparison[36].	2024	Victor C et al.	Prospective study	87	USA
Pain perception among patients treated with passive self-ligating fixed appliances and Invisalign® aligners during the first week of orthodontic treatment[37].	2017	Naif N. Almasoud & Al.	Prospective study	64 patients	Saudi Arabia
Pain Perception in Patients Treated with Ligating/Self-Ligating Brackets versus Patients Treated with Aligner[38].	2022	Farid Bourzgui et Al.	Cross sectional study	346 patients	Morocco
The impact of non-extraction orthodontic treatment on oral health-related quality of life: clear aligners versus fixed appliances—a randomized controlled trial[39].	2022	Alaa M. H. Alfawal et Al.	Randomized controlled trial	44 patients	Syria

Table 1. Data extraction from selected reports after PRISMA (n=12)

4.2. Result tables

Article	Measurement Method
Correa et al. (2024)	Oral health related quality of life (OHRQoL) questionnaire focused on the Oral health impact profile 14 (OHP-14), State trait anxiety inventory (STAI)
Wiedel et al. (2016)	Validated self-reported questionnaire (pain, discomfort, jaw impairment)
Azaripour et al. (2015)	Patient self-reported satisfaction questionnaire about quality of life & periodontal indexes
Alajmi et al. (2019)	Patient self-reported satisfaction questionnaire about limitations to daily routine and use of pain analgesics
White et al. (2017)	Visual Analogue Scale (VAS) questionnaire
Wang et al. (2024)	Oral health related quality of life (OHRQoL) questionnaire focused on the Child Perceptions Questionnaire (CPQ), Depression Anxiety Stress Scale (DASS)
Casteluci et al. (2020)	Visual Analogue Scale (VAS) questionnaire on pain & anxiety
Baseer et al. (2021)	Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ), Child Oral Health Impact Profile
Chan et al. (2024)	Visual Analogue Scale (VAS), Digital self-reported pain surveys
Almasoud et al. (2017)	Visual Analogue Scale (VAS) questionnaire
Bourzgui et al. (2022)	Visual Analogue Scale (VAS)
Alfawal et al. (2022)	Oral health related quality of life (OHRQoL) questionnaire

Table 2. Methods used to measure and analyze pain, discomfort and impact on quality of life of the orthodontic appliances

Article	Results/Outcomes	Summary	Conclusion
Correa et al. (2024)	Brackets group experienced higher physical pain, while aligners group had higher psychological discomfort. No significant difference in anxiety levels.	Brackets impacted oral health-related quality of life (OHRQoL) more negatively compared to aligners during the first month. Anxiety levels remained unaffected by the treatment type.	Aligners generally cause less physical discomfort than brackets but may contribute to psychological distress. No impact on anxiety.
Wiedel et al. (2016)	Higher pain and discomfort in fixed appliance group in the first three days; removable group experienced more speech difficulties.	Fixed appliances caused more pain initially, but removable appliances interfered with speech more.	Both treatment modalities are well-accepted, with minor differences in pain and discomfort.
Azaripour et al. (2015)	Invisalign users had better gingival health and were more satisfied compared to fixed appliance users.	Aligners resulted in better periodontal health and greater patient satisfaction.	Invisalign aligners are associated with improved oral hygiene and patient satisfaction compared to braces.
Alajmi et al. (2019)	Aligners led to better chewing ability and fewer ulcerations but negatively impacted speech.	Aligners provided better comfort for eating and caused fewer soft tissue issues but impaired speech in the short term.	Aligners are generally better tolerated except for speech-related difficulties.
White et al. (2017)	Brackets caused significantly more	Patients with brackets reported	Aligners provide a more comfortable

	discomfort than aligners, especially in the first week.	higher pain levels and took more painkillers.	experience compared to brackets.
Wang et al. (2024)	Aligners showed better functional, emotional, and social well-being impact than fixed appliances.	Clear aligners were associated with better oral health-related quality of life compared to fixed appliances.	Aligners are a preferable choice for children and adolescents due to better comfort and quality of life impact.
Casteluci et al. (2020)	Pain intensity was not significantly different between groups; both peaked in the first week.	Pain levels were similar between aligners and fixed appliances, with peak pain occurring in the first week.	Neither treatment was superior in terms of pain intensity over the long term.
Baseer et al. (2021)	Fixed orthodontic patients reported significantly higher difficulty in sleeping, sores on the tongue and cheeks, and food impaction compared to removable appliance patients.	Fixed appliances resulted in greater discomfort, pain, and food impaction, whereas removable appliances (aligners) were associated with fewer negative impacts on daily life.	Fixed orthodontic treatment had a greater impact on oral health-related quality of life, particularly in terms of pain and discomfort, compared to removable aligners.
Chan et al. (2024)	Brackets resulted in higher pain levels at several time points, particularly during adjustments.	Pain was more intense and lasted longer with fixed appliances compared to aligners.	Aligners are a less painful alternative to fixed appliances over the treatment period.
Almasoud et al. (2018)	Pain was significantly lower in the aligners group compared to	Aligners caused less pain than passive self-ligating brackets,	Aligners provide a more comfortable experience during

	fixed self-ligating appliances.	especially during the first week.	early orthodontic treatment.
Bourzgui et al. (2022)	Aligners caused significantly less pain than conventional or self-ligating brackets.	Patients with aligners reported lower pain intensity and less impact on daily activities.	Aligners are the preferred option for reducing pain and discomfort during orthodontic treatment.
Alfawal et al. (2022)	Clear aligner patients reported significantly better oral health-related quality of life and shorter treatment duration compared to fixed appliance patients.	Clear aligners had a lower impact on psychological and physical discomfort, pain levels, and social disability compared to fixed braces.	Clear aligners are associated with improved oral health-related quality of life and a shorter treatment duration compared to fixed appliances.

Table 3. Summary & data extraction of the results and conclusions of the outcome

5. DISCUSSION

5.1. Comparaison of pain perception: Braces vs aligners

5.1.1. Onset and localization of pain

Correa et al observed that orthodontic pain does not begin immediately after appliance placement, but typically becomes noticeable a few hours afterward [28]. Our results are in line with the available literature, which commonly agree that pain associated with orthodontic treatment typically begins within the first 24 hours following appliance placement or adjustment [32,36]. Similarly, another of our included study reported minimal discomfort within the first hour of placement, followed by a significant increase in pain by the end of the day [29]. The onset of pain corresponds to a biological inflammatory reaction in the periodontal ligament. Several included studies noted that pain intensity often peaks at approximately 24 hours after the initial arch wire activation [31,32]. After reaching this peak at one day, the pain gradually diminishes over the next few days in most patients [33,34]. Pain levels typically return to near baseline by around one week post-adjustment [35-37]. This pattern was described by Giannopoulou et al. and Nicolay et al., the increase in discomfort during the first day correlates with the release of inflammatory mediators such as prostaglandin E2 (PgE2) and interleukin-1β (IL-1β), which sensitize nociceptors in the PDL [40,41]. These mediators are found in high concentrations in gingival crevicular fluid within the first 24 hours and gradually decrease over the following days, explaining the observed reduction in pain by the end of the first week[40].

With regards with pain localization, the included studies generally found that discomfort was not confined to a single tooth but rather spread across the region under treatment[32]. One included study reported that upper and lower incisors were often the most sensitive teeth following initial arch wire placement [38]. Another study noted that while the pain was diffuse, it tended to be most intense in the teeth directly experiencing the orthodontic force [39]. Notably, none of the included studies found pain strictly localized to one tooth; patients typically described soreness affecting multiple adjacent teeth or even broader areas of the tempura mandibular joints. For patients wearing clear aligners, the pain tends to be more localized, and according to Fujiyama et al., it can result from improperly contoured trays, deformed aligners, or sharp edges around attachments, which may irritate soft tissues or apply uneven pressure to specific teeth [42]. Beyond the teeth, pain and discomfort usually extend to the surrounding oral structures. Patients wearing fixed appliances frequently report soreness in the inner cheeks, lips, and gingiva due to the presence of brackets and wires that may cause friction or ulcerations

[31,35]. In contrast, clear aligners users generally experience less irritation in these regions, although poorly trimmed or ill-fitting aligners can still lead to discomfort in the mucosa and gingival margins [42].

5.1.2. Evolution, duration and intensity of pain

The evolution of pain over the course of treatment has also been explored. Several studies noted that while the initial discomfort tends to peak within the first 24 to 48 hours, subsequent appointments or aligner changes often lead to milder symptoms [36,38]. Patients using clear aligners reported a more stable pain profile over time, possibly due to the more controlled and lighter forces applied during each tray transition. Patients wearing fixed appliances, on the other hand, experience recurrent but often diminishing discomfort after each adjustment session, especially after the first month when adaptation mechanisms begin to take place[37].

Intensity is a fundamentally subjective parameter based solely on patient self-report. To assess intensity most of the studies in our results quantified pain either with a visual analogue scale (VAS), or with questionnaire. Pain intensity reach its peak at 24 h in both treatment groups, yet the mean visual-analogue-scale (VAS) score was almost 40 % lower among clear-aligner (CA) patients than among fixed-appliance (FA) patients [34]. By 72 h the inter-group difference narrowed, and by day 7 most participants regardless of the type appliance reported only mild discomfort [32,37].

In the matter of qualitative intensity of pain characteristics, FA patients most frequently described their discomfort as “sharp”, “throbbing”, “hot-burning” or “shooting” [31,36,38]. Aligning with nociceptive input from compressed periodontal tissues and soft-tissue trauma caused by brackets and arch wires [42,43]. By contrast, CA users tended to employ terms such as “aching”, “cramping” or “tender”, indicating a more diffuse, pressure-type soreness rather than acute stabbing pain [30,38,42]. These qualitative distinctions support the quantitative data showing greater peak intensity with fixed appliances. As for quantitative criterias of intensity of pain, we also observe differences depending on the appliance configuration. Almasoud et al recorded the mean day-1 VAS on FA patients of 6.0 ± 3.41 versus 1.38 ± 2.69 for CA users [37]; a similar gap was reported in mixed-dentition therapy [29]. A recent systematic review conducted by Pereira et al. confirmed that aligners reduce peak pain by roughly one-third compared with conventional brackets [44]. Conversely, it is worth noting a controversy in one study of our results where the authors argued that the higher pain scores reported by FA patients were essentially

driven by aphthous ulcers and mucosal abrasions caused by metal components and not by orthodontic tooth movement [34]. This hypothesis raises the possibility that soft-tissue injury are accountable for a substantial part of the intensity gap.

5.1.3 Need of analgesics

Differences in pain intensity manifest into distinct patterns of analgesic consumption. White et al. found that 45% of FA patients took non-steroidal anti-inflammatory drugs (NSAIDs) within the first 48 h, compared with 11% of CA patients [32]. This contrasts with data of the wear of conventional bracket from Polat, where up to 90 % of patients resorted to medication after routine adjustments [43]. In our cohort, fewer than one-third of clear aligners users reported any drug intake at any time-point, corroborating evidence that milder pain with aligners reduces pharmacological burden [31]. Caldas et al. highlighted that within the CA group, individuals whose discomfort persisted beyond three days were twice as likely to self-medicate, indicating that duration as well as peak intensity drives analgesic use [45].

Chronologically, pain becomes progressively easier to tolerate. Chan et al. with their prospective cohort recorded reduction in mean VAS between the first and second adjustment visits, with subsequent activations [36]. This finding is in line with Bourzgui et al which show that each successive adjustment induces weaker nociceptive responses as both biological adaptation and patient habituation occur [38]. Analgesic consumption follows the same downward trajectory. White et al. studied the intake of medications for 1 week and the results showed that both proportion of FA & CA patients using NSAIDs fell, respectively from 50 % after the initial visit to 14 % after the second, while CA users dropped from 25 % to below 10 % over the same interval [32]. Both our results and literature underscore that although acute orthodontic pain can be pronounced, especially with fixed appliances, it is transient, typically subsiding within a week. The parallel fall-off in analgesic use further illustrates how discomfort diminishes as treatment progresses and patients adapt.

5.2. Discomfort and impact on Oral Health Related Quality of Life

5.2.1. Functional limitations: Eating and speaking

Functional limitations, particularly those affecting eating and speaking, are among the most reported discomforts during orthodontic treatment and significantly influence patient quality of life. Alajmi et al. reported that 76 % of patients wearing fixed appliances complained of chewing difficulty during the first treatment month, whereas close to 0 % of clear-aligner

users reported comparable problems [31]. This finding is in line with a cohort conducted by Baseer et al. in which FA patients scored significantly worse than CA patients on the "eating hard foods" item of the OHIP-14, particularly within the first six weeks of therapy [35]. Additionally, fixed appliance tends to limit both the quantity and variety of foods they feel comfortable consuming, nevertheless, self-reports indicate that these restrictions seldom doesn't interfere with the enjoyment of food or with the act of swallowing itself [31]. Because chewing with braces can be markedly more painful, particularly in the first 48 h after an adjustment, several patients noted a reduced desire to eat or even skipped meals until the soreness lowered [32]. Broader literature corroborates these appliance-related differences. Gao et al. reported that patients with aligners experienced significantly fewer dietary restrictions and regained normal chewing sooner than patients with fixed appliances in the initial three-week phase of treatment [46]. Collectively, these studies suggest that while eating discomfort peaks early for all orthodontic modalities, the removability of aligners and the absence of brackets nuance functional impairment at mealtimes [47].

Speech disturbance appears to be almost exclusively associated with removable appliances as the clear-aligner tray covers the palatal surfaces and temporarily disrupts tongue placement for particular sibilant sounds. Wiedel et al. reported that more than half of aligners wearers noticed an altered pronunciation during the first two weeks, whereas virtually no fixed-appliance patients reported mechanical speech impediments [29]. The same study followed participants longitudinally and showed that this disturbance could persist for up to eight weeks before full accommodation of tongue position was achieved. Alajmi et al. echoed this trend, finding that aligners users recorded significantly worse scores on the "speaking clearly" item of the OHRQoL questionnaire during the first month, while patients with braces showed minimal change [31]. This finding is in line with Shalish et al. study which observed that nearly 60 % of adult Invisalign patients reported a noticeable lisp during the first week of wear, but the prevalence fell below 15 % by the second month as articulation adapted [48].

5.2.2. Oral hygiene

Significantly higher Plaque Index and Gingival Index scores were reported in fixed-appliance (FA) patients than in clear-aligner (CA) users after three months of active treatment [30]. Similarly, it was also found that FA patients scored worse on the "food impaction" and "difficulty keeping teeth clean" items of the Oral Impacts on Daily Performance (OIDP) during the first six weeks, whereas CA patients showed only minor changes from baseline [31]. Wang et al. confirmed this trend in a pediatric cohort: CA wearers maintained near-baseline

gingival health, while FA subjects demonstrated a significant rise in bleeding-on-probing scores within eight weeks [33]. These findings indicate that fixed brackets and arch wires create additional plaque-retentive niches that challenge daily hygiene, whereas the removability of aligners allows patients to brush and floss almost as effectively as before treatment. The broader literature reinforces these observations. Karkhanechi et al. followed adult patients for one year and showed that FA therapy produced a two-to-three-fold increase in mean plaque and gingival scores, while CA therapy kept periodontal parameters within healthy limits throughout the observation period [49]. The authors attributed this discrepancy to the mechanical impediment posed by brackets and elastomeric ligatures, which favor biofilm accumulation and gingival inflammation.

Brushing itself can be painful for braces wearers. Bourzgui et al. found that almost two-thirds of adolescents with conventional or self-ligating brackets reported soreness specifically during tooth-brushing in the first treatment week [38]. Rakhshan et al. noted that, in the initial phase of active therapy, patients frequently shortened brushing time because gingival tenderness around brackets made routine hygiene uncomfortable [50]. Such brush-related pain was far less common in clear-aligner users.

5.2.3. Halitosis

With respect to halitosis, our own dataset did not reveal a consistent appliance effect. Both Alajmi et al. and Baseer et al. found no statistically significant difference in self-reported bad-breath scores between clear-aligner and fixed-appliance groups during the first six weeks of treatment [31,35]. Longer-term follow-up by Karkhanechi et al. observed an early, non-significant trend toward more halitosis complaints in FA patients that disappeared by 12 months [49]. These mixed findings, addressed by Shalish et al., suggest that any appliance-related difference in halitosis is likely small and transient, and may depend more on individual hygiene practices than on bracket or tray design [48].

5.2.4. Patient satisfaction : Psychosocial impact and aesthetic

Correa et al. noticed that patients treated with clear aligners reported significantly lower levels of social embarrassment when smiling compared to those wearing brackets [28,31]. A similar pattern emerged in our pediatric cohort, where aligners wearers were significantly less likely than brace wearers to be teased or to conceal their smile during the initial eight-week period [33]. These findings are in line with Shalish et al., who showed that adult Invisalign users

scored best on "self-conscious about appearance" during the first two months [48]. Taken together, the data indicate that the discrete appearance of aligners confers an early advantage in aesthetic self-confidence. Dianiskova et al. found that children treated with aligners expressed higher personal aesthetic satisfaction, although parental satisfaction did not differ significantly from that associated with traditional braces [51].

Outcome studies extending beyond the active phase provide a more tempered picture. Gu et al. and Borda et al. both reported higher post-treatment self-image ratings among aligner patients compared with brace patients, but the magnitude of the difference was limited once satisfactory alignment had been achieved in both cohorts [52,53]. These data suggest that even though aligners come with a clear aesthetic advantage during the initial months (when psychosocial sensitivity to appearance is greatest), final satisfaction levels converge once appliances are removed, and smiles are fully corrected [31].

5.3. Anxiety

Anxiety is another subjective variable difficult to assess but typically measured with the Stait Trait Anxiety Inventory (STAI). Conflictual results were found on the literature available. While most scientific studies indicated no substantial differences in anxiety levels overall, specific studies described lower anxiety scores for aligner patients during initial treatment days. Correa et al. reported a significant drop in STAI-State scores during the first three months for adults treated with clear aligners, whereas fixed-appliance (FA) patients showed no meaningful change [28]. Tunca et al. confirmed this short-term advantage for aligners, finding lower STAI-State values at both one and three months in the CA group [54].

This light gap of anxiety level appears temporary. Baseer et al. found no difference in the "psychological disability" domain of the OHIP-14 at six weeks, and Alfawal et al. observed that the initial so-called disadvantage attributed to fixed appliances patients had disappeared by month 6 [35,39]. Weekly tracking by Wang et al. showed that declines in pain paralleled and were moderately correlated with declines in STAI-State scores over the first eight weeks, regardless of appliance type [55]. These findings suggest that early pain control is key to reducing treatment-related anxiety.

5.4. Limitations

The primary limitation of the present analysis lies in the subjective nature of pain and discomfort assessment. Visual analogue scales and similar self-report tools remain the gold standard, yet they cannot be fully objective: patient ratings are modulated by ethnicity, cultural norms, socioeconomic status, personality traits (e.g., hypervigilance), prior painful experiences, and individual pain-modulation profiles [56]. These sources of variability introduce measurement noise and potential bias when comparing groups. In addition, momentary fluctuations in mood or situational anxiety can shift a rating even within the same individual, complicating longitudinal interpretation. Finally, because oral-health–related quality-of-life and psychosocial questionnaires are likewise self-reported, correlations between pain and quality-of-life outcomes may be inflated by shared method variance.

5.5. Recommendations and futures directions

Future research should continue focusing on pain management strategies, the development of clear aligner technologies capable of addressing more complex orthodontic cases, and patient education initiatives aimed at managing expectations. Additionally, there is a need to conduct longitudinal studies with larger sample sizes to thoroughly understand pain evolution over longer treatment periods and its sustained impact on quality of life and compliance.

Clinicians should remain mindful of the individual variations in patient experiences when recommending treatment modalities. Personalized approaches, considering both clinical complexity and patient preferences for aesthetics and comfort, will lead to enhanced patient outcomes and greater satisfaction overall.

6. CONCLUSIONS

The primary objective of this study was to assess the perception of pain and discomfort in orthodontic patients undergoing treatment with either fixed appliances or clear aligners.

1. Based on the current scientific literature, it appears that clear aligners are generally better tolerated in terms of pain intensity, onset, and duration. Patients treated with aligners frequently report lower levels of discomfort, particularly during the first few days following appliance activation, a period often characterized by peak pain perception. This reduced discomfort is largely attributed to the intermittent and lighter forces applied by aligners, in contrast to the continuous mechanical forces generated by fixed appliances such as brackets and wires. Additionally, aligners tend to cause fewer oral lesions such as mucosal ulcerations, sores, and food impaction, further contributing to their improved tolerance. While fixed appliances are still indispensable in treating more complex orthodontic cases requiring precise control of tooth movement, their association with higher levels of pain may influence patient compliance, satisfaction, and motivation—especially in young or pain-sensitive individuals. Therefore, understanding the patient's pain profile and psychological predisposition remains critical for tailoring orthodontic treatment to individual needs.

2. Aligned with the secondary objective, this study also examined the broader impact of pain and discomfort on the patient's oral health-related quality of life (OHRQoL). The findings suggest that the type and severity of discomfort experienced throughout treatment significantly influence functional, emotional, and social well-being. Clear aligners, due to their discreet design and removability, offer greater comfort in daily life and minimize the psychological burden often associated with visible orthodontic appliances. This contributes to higher levels of satisfaction and stronger adherence to treatment protocols. In contrast, fixed appliances—although effective from a biomechanical standpoint—often impair speech clarity, increase the risk of food retention, and reduce self-confidence due to aesthetic concerns. As a result, aligners appear to provide not only a physically less painful experience but also a more favourable psychological and social adjustment to treatment. These findings reinforce the importance of integrating OHRQoL assessments into clinical decision-making, emphasizing that orthodontic success should be measured not only by dental alignment but also by the patient's comfort, experience, and quality of life throughout the treatment process.

7. SUSTAINABILITY

This study contributes to the achievement of Sustainable Development Goal 3 (Good Health and Well-being) by analysing how orthodontic treatment modalities impact patients' physical and psychological well-being. By highlighting the reduced pain and discomfort associated with clear aligners compared to fixed appliances, the project promotes more sustainable and patient-friendly healthcare practices. From a social sustainability perspective, enhancing comfort and treatment adherence can reduce health inequalities, especially among patients with high anxiety or lower pain tolerance. The greater aesthetic and psychological acceptability of aligners may also encourage access to care among adolescents and working adults.

In terms of economic sustainability, aligners may lead to fewer emergency visits and lower use of pain medications, which reduces healthcare costs and improves resource efficiency in dental practices. Finally, from an environmental perspective, the shorter treatment duration and lower need for repeated interventions with clear aligners can contribute to reduced material waste (e.g., broken brackets, replacement wires) and energy use in clinics. Promoting digital treatment planning and 3D printing technologies in aligner therapy may also reduce environmental footprints over time. Thus, this project aligns with ethical and sustainable principles in modern orthodontics.

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9. ANNEXES

Figure 4: PRISMA 2000 Flow diagram - Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n7.

RESEARCH METHODS AND REPORTING

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The PRISMA 2020 statement: an updated guideline for reporting systematic reviews

Matthew J Page,[1] Joanne E McKenzie,[1] Patrick M Bossuyt,[2] Isabelle Boutron,[3] Tammy C Hoffmann,[4] Cynthia D Mulrow,[5] Larissa Shamseer,[6] Jennifer M Tetzlaff,[7] Elie A Akl,[8] Sue E Brennan,[1] Roger Chou,[9] Julie Glanville,[10] Jeremy M Grimshaw,[11] Asbjørn Hróbjartsson,[12] Manoj M Lalu,[13] Tianjing Li,[14] Elizabeth W Loder,[15] Evan Mayo-Wilson,[16] Steve McDonald,[1] Luke A McGuinness,[17] Lesley A Stewart,[18] James Thomas,[19] Andrea C Tricco,[20] Vivian A Welch,[21] Penny Whiting,[17] David Moher[22]

For numbered affiliations see end of the article.

Correspondence to: M J Page matthew.page@monash.edu (ORCID 0000-0002-4242-7526)

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The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement, published in 2009, was designed to help systematic reviewers transparently report why the review was done, what the authors did, and what they found. Over the past decade, advances in systematic review methodology and terminology have necessitated an update to the guideline. The PRISMA 2020 statement replaces the 2009 statement and includes new reporting guidance that reflects advances in methods to identify, select, appraise, and synthesise studies. The structure and presentation of the items have been modified to facilitate implementation. In this article, we present the PRISMA 2020 27-item checklist, an expanded checklist that details reporting recommendations for each item, the PRISMA 2020 abstract checklist, and the revised flow diagrams for original and updated reviews.

SUMMARY POINTS

To ensure a systematic review is valuable to users, authors should prepare a transparent, complete, and accurate account of why the review was done, what they did, and what they found

The PRISMA 2020 statement provides updated reporting guidance for systematic reviews that reflects advances in methods to identify, select, appraise, and synthesise studies

The PRISMA 2020 statement consists of a 27-item checklist, an expanded checklist that details reporting recommendations for each item, the PRISMA 2020 abstract checklist, and revised flow diagrams for original and updated reviews

We anticipate that the PRISMA 2020 statement will benefit authors, editors, and peer reviewers of systematic reviews, and different users of reviews, including guideline developers, policy makers, healthcare providers, patients, and other stakeholders

Systematic reviews serve many critical roles. They can provide syntheses of the state of knowledge in a field, from which future research priorities can be identified; they can address questions that otherwise could not be answered by individual studies; they can identify problems in primary research that should be rectified in future studies; and they can generate or evaluate theories about how or why phenomena occur. Systematic reviews therefore generate various types of knowledge for different users of reviews (such as patients, healthcare providers, researchers, and policy makers).[1 2] To ensure a systematic review is valuable to users, authors should prepare a transparent, complete, and accurate account of why the review was done, what they did (such as how studies were identified and selected) and what they found (such as characteristics of contributing studies and results of meta-analyses). Up-to-date reporting guidance facilitates authors achieving this.[3]

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement published in 2009 (hereafter referred to as PRISMA 2009)[4-10] is a reporting guideline designed to address poor reporting of systematic reviews.[11] The PRISMA 2009 statement comprised a checklist of 27 items recommended for reporting in systematic reviews and an "explanation and elaboration" paper[12-16] providing additional reporting guidance for each item, along with exemplars of reporting. The recommendations have been widely endorsed and adopted, as evidenced by its co-publication in multiple journals, citation in over 60 000 reports (Scopus, August 2020), endorsement from almost 200 journals and systematic review organisations, and adoption in various disciplines. Evidence from observational studies suggests that use of the PRISMA 2009 statement is associated with more complete reporting of systematic reviews,[17-20] although more could be done to improve adherence to the guideline.[21]

Many innovations in the conduct of systematic reviews have occurred since publication of the PRISMA 2009 statement. For example, technological advances have enabled the use of natural language processing and machine learning to identify relevant evidence,[22-24] methods have been proposed to