

Comparative Efficacy of Clear Aligners vs. Braces for Overbite Correction

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Abstract. Overbite is a super common malocclusion impacting millions of people every year. While braces are the traditional treatment method, CAT (Clear Aligner Therapy) has been gaining popularity recently, and efficacy between these 2 treatments remains unclear. The aim of the study is to compare the efficacy of CAT and fixed braces in treating mild-to-moderate and severe cases of overbite. A literature-based analysis was used. Biomechanical mechanisms were reviewed first, and then studies with different clinical trials were synthesized to address the claim. For mild to moderate overbite, CAT and braces achieved comparable efficacy, with CAT having a shorter average treatment duration. For severe overbite, fixed braces offered a far higher efficacy due to their ability to produce more incisor intrusion and vertical control, while CAT showed primarily dentoalveolar correction. In conclusion, the efficacy of orthodontic treatment for overbite can depend on the severity of the case. Clear aligners offer a comparable solution to braces for mild-to-moderate overbite cases, while braces remain the best method for more severe cases.

Keywords: Clear aligner therapy, fixed orthodontic appliances, overbite correction

1. Introduction

Overbite is a type of malocclusion in which the upper teeth overlap the lower teeth. It is an extremely common condition and, if mild, can even be a sign of good dental health. However, if the upper teeth overlap the lower teeth by more than 2 to 4 millimeters, then the overbite needs treatment [1]. Tooth erosion, jaw pain, and gum disease are all potential effects that occur from an overbite [1]. Socially, an overbite can create an uneven smile and lead to a lack of self-confidence about one's appearance.

Braces are the traditional treatment for orthodontic issues, including overbite, and are by far the most popular option. Metal braces are the most common type and consist of stainless-steel bands, brackets, and an archwire. The adjustable archwire runs through all the brackets and is the main driver guiding the teeth to the correct position. Braces catalyze a process called bone remodeling, and Class II elastics are prescribed to help provide additional pressure and assist with teeth and jaw alignment [2]. Braces are extremely reliable because they are not easily removable, ensuring full compliance.

CAT is a newer orthodontic treatment that has been increasing in popularity recently. CAT consists of clear plastic trays molded to a specific shape to change a patient's tooth structure over

time. The plastic trays are flexible because they are made of materials like polyurethane. Additionally, orthodontists will often prescribe power ridge and button attachments to assist with treatment [3]. These aligners do have to be replaced every 2 weeks to ensure consistent pressure, because they don't have a changeable wire like braces. Clear aligners are removable, appear invisible, and are more comfortable than braces.

This investigation will compare the efficacy of braces and CAT across 2 severities of overbite: mild-to-moderate and severe. Biomechanics will be included to give background information on how each treatment works. Various literature will be studied and analyzed with the intention to support the claim that braces have higher efficacy for severe cases, while they have comparable efficacy to CAT in mild-to-moderate cases.

2. Biomechanical mechanisms

2.1. Biomechanical mechanisms of braces

Bone remodeling starts when braces apply pressure to a tooth, creating an area of compression on one side with resulting tension on the other. In the area of compression, bone is removed, and the other side grows new bone, slowly changing tooth structure over time [2]. Orthodontists progress treatment by replacing the archwire or tightening it. They will also give patients class II elastics to further progress. There are 2 types of elastics that both connect the maxillary canine/anterior region to the mandibular molar region: long and short. Long elastics provide more force above the lower arch's center of resistance and below the upper arch's center, pulling both arches clockwise. As a result, molar extrusion and occlusal plane steepening happen. Conversely, short elastics have the same mechanisms with a closer line of action to both centers of resistance. This creates less rotation, making short elastics better for vertical control [4]. Both contribute to treating overbite. In summary, long elastics are more forceful, but short elastics offer better vertical control.

2.2. Biomechanical forces of clear aligners

Clear aligners and braces use a similar biological mechanism to fix malocclusions. Like braces, aligners create areas of compression and tension within the periodontal ligament, which triggers inflammation and bone remodeling, leading to tooth movement. However, aligners use different materials than braces. Instead of a continuous pull from archwire and brackets, clear aligners use custom-molded plastic trays to deliver an intermittent push force, each programmed for 0.20-0.33 mm of movement [5]. For overbite, the bone remodeling happens in 2 directions. The upper front teeth need to be pushed up into the bone, while the lower teeth need to come forward to reduce the gap. Orthodontists use attachments and pressure points bonded to the teeth to better direct force. When Class II elastics are added through buttons, the effect is similar to elastics on braces. However, the remodeling mainly affects the teeth rather than the jaw. Furthermore, the remodeling only works effectively if the aligners are worn for 20-22 hours a day, because removal halts the inflammatory cascade and reverses progress [6]. Compliance is critical for efficacy in CAT and is a huge problem in adolescents, which will be discussed later.

3. Comparative analysis of clinical outcomes

This section will review clinical evidence and studies from different sources analyzing efficacy of CAT and fixed braces to conclude which treatment has better efficacy overall for mild/moderate and

severe overbite cases. The severity of overbite will depend on vertical overlap and skeletal discrepancy for this study. There are many definitions of mild-to-moderate and severe overbite, but for the sake of consistency, 3-5 mm is mild-to-moderate overbite and > 5 mm is severe overbite [7]. Overjet is dependent on horizontal overlap, while deep bite is based on increased vertical overlap. Since there aren't studies that clearly compare fixed braces and clear aligners for overbite correction, this paper compares many different studies on these 2 treatment methods to come up with a clinical conclusion.

3.1. Comparable efficacy in mild to moderate overbite

Fixed braces and CAT therapy both provide sufficient treatment in overbite reduction for mild-to-moderate cases. Pham et al. [8] ran a randomized controlled trial comparing these 2 treatments on deep bite cases. While there is no direct statement saying that mild-to-moderate cases were analyzed, the inclusion criteria point to it. Deep bite in this study is considered as an overbite exceeding one-third of the lower incisor crown length. According to an average mandibular incisor crown length of 9 mm, one-third of 9 mm is 3 mm, meaning that > 3 mm is considered a deep bite in this study [9]. It is important to note that the 9 mm value is an approximation used to set a consistent crown length, and there are a few outliers that exceed mild-to-moderate criteria. Pham et al. [8] found no statistically significant difference in overbite improvement ($P=.461$) or overjet reduction ($P=.603$). Pham et al. [8] also found that the main difference in treatment was duration, with CAT having a significantly shorter treatment time than fixed braces (20.77 ± 6.43 months vs 27.47 ± 4.81 months, $P<.001$). This data directly shows that fixed braces and CAT have unnoticeably different efficacy in mild to moderate cases, and CAT is more efficient due to the shorter average treatment duration.

Lin et al. [10] noted that CAT was initially created to fix mild to moderate crowding and spacing, but has since been applied to vertical discrepancies. This shows that clear aligners were designed to deal with milder cases. Also, in their systematic review of literature, Lin et al. [10] reported a median overbite reduction of 1.5 mm in deep-bite patients and a similar increase in open-bite patients when using CAT. Logically, a median of 1.5 mm is clinically sufficient to normalize a mild overbite case of 3-5 mm, except cases over 4.5 mm; however, other methods can be used with clear aligners to ensure these cases go under 3 mm.

Additionally, Lin et al. [10] concluded that CAT "could be recommended only for mild deep overbite correction." They also found that CAT had less impact on controlling vertical movements of the incisors than fixed braces. This supports the comparison with the recent study by Pham et al. [8], who found no significant difference in overbite improvement between fixed braces and aligners, but noted that braces offered superior vertical control. In severe cases where vertical control is needed, this directly shows that CAT isn't optimal.

3.2. Braces in severe skeletal overbite

In severe cases of overbite with skeletal discrepancies, braces have been shown to work better than clear aligners. In an investigation studying the skeletal and dental effects of clear aligners in class II case correction, Patel et al. [11] found that CAT in growing patients offered no significant change in skeletal parameters, and correction was primarily dentoalveolar. This shows that clear aligners would not be sufficient in severe overbite cases needing skeletal change. Additionally, the 1.5 mm median overbite reduction reported in the study conducted by Lin et al. [10] indicates that CAT therapy cannot provide the correction needed in severe cases with over 5 mm of overbite. Hosseini

et al. [12] found that fixed braces provide superior vertical control through reverse-curve archwires and fixed appliances such as the Herbst for skeletal modification. As a result, braces are the better treatment option due to their ability to provide the required skeletal and vertical changes needed to treat severe cases of overbite.

4. Discussion and evaluation

This research analyzed the efficacy of clear aligners and braces in overbite treatment to determine which is better depending on severity. After a broad literature review, it is clear that braces are the better option in severe cases of overbite, while there is no significant difference in treatment for mild-to-moderate cases other than treatment time. In mild-to-moderate cases, the incisors have only grown slightly. A median 1.5 mm intrusion was discovered through a literature review on CAT, and this is sufficient in correcting most mild-to-moderate cases. This does support why studies like Pham et al. [8] concluded that there isn't a significant difference between the 2 treatments. If CAT is sufficient in solving the cases, then the braces will be as well. However, in severe cases, the issues aren't primarily dentoalveolar. For example, the lower jaw can be misaligned in the mouth. This issue requires skeletal modification and vertical control. Patel et al. showed that CAT can't provide the necessary modification needed in these types of cases.

The statistics in study conducted by Pham et al. [8] further strengthen the claim of comparable efficacy. Pham et al. [8] found no significant difference in overbite improvement ($P=0.461$) or overjet reduction ($P=.603$) between the two treatment options. Since the P value is greater than 0.05, the null hypothesis can't be rejected, meaning that there is not enough evidence to prove that either treatment method is significantly superior in mild-to-moderate cases of overbite.

Random errors make results less accurate by creating unpredictable scatter in results. In the studies analyzed, compliance is the main source of random error. Efficacy of CAT is mainly confounded by compliance. Timm et al. [13] reported that adolescents wear their aligners 10-20 hours on average per day rather than the recommended 20-22 hours optimal for effective treatment. The patients in these studies self-report wear time, and there is nothing to ensure some patients don't lie. This insufficient and wavering wear time causes variation, increasing standard deviation and reducing precision in the data analyzed.

Systematic errors shift the results in one direction and make a study less accurate. In the studies analyzed, there is a fair amount of selection bias. Some studies took samples from specific clinics and one geographical location without randomization. Additionally, clinics are more likely to publish cases that offer the clearest results, which can potentially overestimate CAT efficacy.

The biggest limitation in our study is that no study directly compares braces and CAT in overbite, while splitting patients into mild/moderate vs. severe cases. This investigation took many different studies that all had different ages, methodologies, locations, and research questions, so there is no consistent data used to come to a conclusion. For example, Lin et al. [10] looked only at CAT, while Pham et al. [8] compared both braces and aligners. Patel et al. [11] studied skeletal effects and jaw movements in different patient groups. Additionally, the external validity of the investigation is limited because the study only focuses on the age groups that the study analyzed, which mainly consist of young adults and adolescents. To fix these limitations for the future, a study that directly compares the efficacy of fixed braces and CAT in all age groups while finding data for mild to moderate cases and severe cases would offer a great solution.

Clinically, this investigation is important because orthodontists need to select the right tool for patients depending on their specific case. For a small overbite, clear aligners would work better due to their comfort, aesthetics, and patient compliance. For a more severe overbite, braces would be the

correct treatment option due to the skeletal aspect of the overbite. This study gives orthodontists the reassurance and guidance through evidence-based literature to prescribe the right treatment at all times.

5. Conclusion

This study compares the efficacy of overbite treatment between CAT and braces in two severity levels. For mild to moderate cases, CAT showed comparable efficacy to fixed braces with a shorter average treatment time than fixed braces. The median intrusion of 1.5mm achievable by CAT is sufficient to address most cases within this group.

For severe overbite, braces have higher efficacy compared to CAT. CAT does not have the capability to achieve enough vertical control and incisor intrusion to solve many severe cases of overbite. Additionally, the median intrusion of 1.5 mm cannot achieve the 4-5 mm correction required for severe overbite cases.

Therefore, clinical orthodontic treatment for overbite is case-dependent on severity. While braces remain the traditional and go-to method for treatment, in mild-to-moderate cases CAT may start to take over due to the many benefits involved.

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