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Evaluation of Discrepancy between Actual and Expected Treatment Outcome in Correction of Increased Overbite Using Clear Aligner Therapy- A Systematic Review

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KEYWORDS
clear aligner therapy, deep bite, overbite correction, predictability, efficacy, systematic review

ABSTRACT:

Introduction: Clear aligner therapy (CAT), an esthetic alternative to fixed appliances, has gained popularity in managing malocclusions, including deep bite. Despite improvements in material and attachment design, several studies have highlighted discrepancies between software-predicted tooth movements and actual clinical outcomes. In particular, vertical control and correction of increased overbite remain challenging, often requiring overcorrection, refinements, or hybrid therapy.

Objectives:

This systematic review aimed to evaluate the discrepancy between expected and achieved treatment outcomes in the correction of increased overbite using clear aligner therapy, focusing on predictability and efficacy.

Methods:

A comprehensive search of PubMed, Cochrane Library, ScienceDirect, and Google Scholar was conducted using predefined keywords. Eligible studies included prospective and retrospective cohorts, randomized and non-randomized clinical trials, case-control, observational, and cross-sectional studies reporting on pre- and post-treatment overbite correction exclusively with clear aligner therapy in patients ≥18 years. Surgical cases and syndromic patients were excluded. Two reviewers independently screened and extracted data, and quality was assessed using adapted scoring protocols. Predictability was defined as the agreement between software-predicted and achieved outcomes, while efficacy was the proportion of actual overbite reduction achieved.

Results:

From an initial pool of articles, 7 retrospective studies met the inclusion criteria, encompassing 575 participants aged 18–55 years. Reported efficacy of overbite correction with aligners ranged between 33% and 46%, with a pooled average of 39.25%. Loss of predictability was consistently high, ranging between 55% and 67%. Extraction cases demonstrated lower accuracy (≈8.7%) compared with non-extraction cases (≈45.8%). Bite ramps and G8 protocols showed minimal additional benefit.

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Conclusions:
Current evidence indicates that clear aligner therapy achieves only about one-third of the software-predicted overbite correction, with significant loss in predictability. Overbite reduction with aligners remains biomechanically challenging, particularly in extraction cases. Further prospective, high-quality studies are needed to establish standardized protocols and improve clinical reliability.

1. INTRODUCTION

Overbite is defined as the vertical overlap of incisal edges between upper and lower anterior teeth. Profitt et al defined ideal overbite is 0-2 mm and overbite ≥ 5mm is considered as severe increase in overbite[1]. It contributes to 95.2% of vertical occlusal problems and is found in 13% of adults and 20% of children[2]. Increased overbite can be attributed due to skeletal, dental and environmental discrepancies. It can be due to supraeruption of Incisors, Infraocclusion of molars, Incisor angulations, Increased Overjet, Increased mandibular ramal height, Decreased mandibular plane angle, reduced anterior lower facial height, lateral tongue thurst or abnormal tongue posture, excessive wear of posterior teeth etc and can be corrected by orthodontic and orthognathic treatment options depending upon the patient's age, severity, Operator's diagnosis and treatment planning. [3,4]Increased overbite can lead to deleterious effects not only on teeth but also on surrounding periodontium and TMJ, therefore, it is important to treat the same.

Over the last decades, clear aligner therapy, which is a devised improvisation of Dr. Harold Kesling's tooth positioner (1946), has gained more popularity and there has been a noticeable shift in trend towards the appliance. Studies have shown that clear aligner therapy is more esthetic, comfortable, has reduce number and duration of appointments, less emergency visits and also provides better oral hygiene control as compared to fixed functional mechanotherapy. [5,6]

According to published research it has been noted that clear aligner therapy has not been very accurate in predicting the amount of tooth movement therefore, mentioning the discrepancy between virtually planned expected and actual treatment outcome achieved with aligners.

In a prospective study carried by Tommaso Castroflorio et al and Kravitz et al[7,8], they noticed that maxillary lateral incisors, canines and premolars showed less accuracy in correction of rotation whereas maxillary central incisor and molars showed astounding precision. In a retropsective study by Maurice J. Meade et al on 282 adults it was found that the overjet achieved was nearly half of predicted overjet and only 1/3rd of planned decrease in overbite was achieved post treatment. Also the accuracy for achieved overbite reduction in non extraction group was 45.83% and was higher than extraction group which achieved only 8.69% overbite correction as that of predicted.[9]

Thus, by keeping in mind the accuracy of software in predicting Orthodontic tooth movement, clinician can anticipate the need of overcorrection, develop newer materials, new attachment's design and placement, moreover, by keeping the aligners biomechanics in mind one can help in reducing the number of refinement scans and switches from aligners to fixed functional therapy due to mid course corrections.

Hence, the aim of this systematic review is to determine the discrepancy between expected and achieved treatment outcome in correction of increased overbite by clear aligner therapy. The article will help to answer the following questions: 1. How effective is clear aligner therapy in correction of increased overbite? 2. Is the overbite correction predicted by the software similar to actual overbite correction achieved post treatment using clear aligner therapy?

2. MATERIALS AND METHODS

Table 1: Eligibility Criteria for Study Selection

Type of Studies	Studies referring to expected and actual treatment outcome in correction of increased overbite using clear aligner therapy

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	Eligible studies were prospective and retrospective cohorts, randomized controlled and uncontrolled trials, case control studies, observational studies, cross sectional studies, All articles published till April 2024
Participants	Inclusion Criteria: Patients aged 18 years or above Pre treatment and post treatment models available Requiring increased overbite correction Orthodontic treatment exclusively by clear aligner therapy Good compliance Exclusion Criteria: Surgical Correction for increased overbite Presence of Cleft lip or palate or syndrome associated orofacial malformation
Intervention	Increased overbite correction with Clear Aligner Therapy
Outcome Measures	Quantitative evaluation of difference between expected and actual treatment outcome in correction of increased overbite under following terms: Predictability - Software predicted overbite correction vs Actual overbite correction Efficacy- Pre treatment overbite correction vs Post treatment overbite correction

The systematic review is based upon PRISMA guidelines and main objective was defined with PICO format[10]

Table 2: PICO FORMAT

Population	Patients having Increased overbite
Intervention	Correction of Increased overbite using Clear Aligner Therapy
Comparison	Predictability- Software expected overbite correction vs actual overbite correction achieved Efficacy- Pre treatment expected overbite correction vs post treatment overbite correction achieved
Outcome	Quantitative evaluation of difference between expected and actual overbite correction

Keywords (Increased overbite correction OR Deep bite correction) AND (Clear Aligner Therapy or Invisalign), (Predictability OR Efficacy) AND (Expected OR Actual) were searched on various search engines like PubMed, Cochrane library and Google Scholar. Initially to identify the potential articles, the search was done by title and abstract and then the final articles were selected by taking inclusion and exclusion criteria into account. Inclusion criteria for the systematic review included prospective and retrospective cohorts, randomized controlled and uncontrolled trials, case control studies, observational studies, cross sectional studies, articles with full text available and all articles in English. Two researchers carry out the selection procedure independently and they compared the outcomes to find differences and lower inter personnel oversights. Inter examiner doubts were solved by discussing and analyzing each article and reaching to an unanimous decision. The methodological quality scoring protocol was an adapted version of 3 methods previously implemented by Chen et al[11], Cozza et al[12] and Fudalej and Antoszewska [13]The characteristics evaluated were study design, sample size and description, error analysis and statistical analysis. Finally, the data from the selected articles was retrieved to analyze the expected and actual treatment outcome in correction of increased overbite using Clear Aligner Therapy

Statistical Analysis

After a meticulous search of electronic databases, --- studies were retrieved from PubMed, --- from Science Direct and --- from Google Scholar. After keeping in mind the inclusion and exclusion criteria and eliminating studies indexed in more than 1 database,--- articles were retrieved. Full text for all these articles were assessed and articles not satisfying the inclusion and exclusion criteria were excluded and finally 7 articles were included in this systematic review

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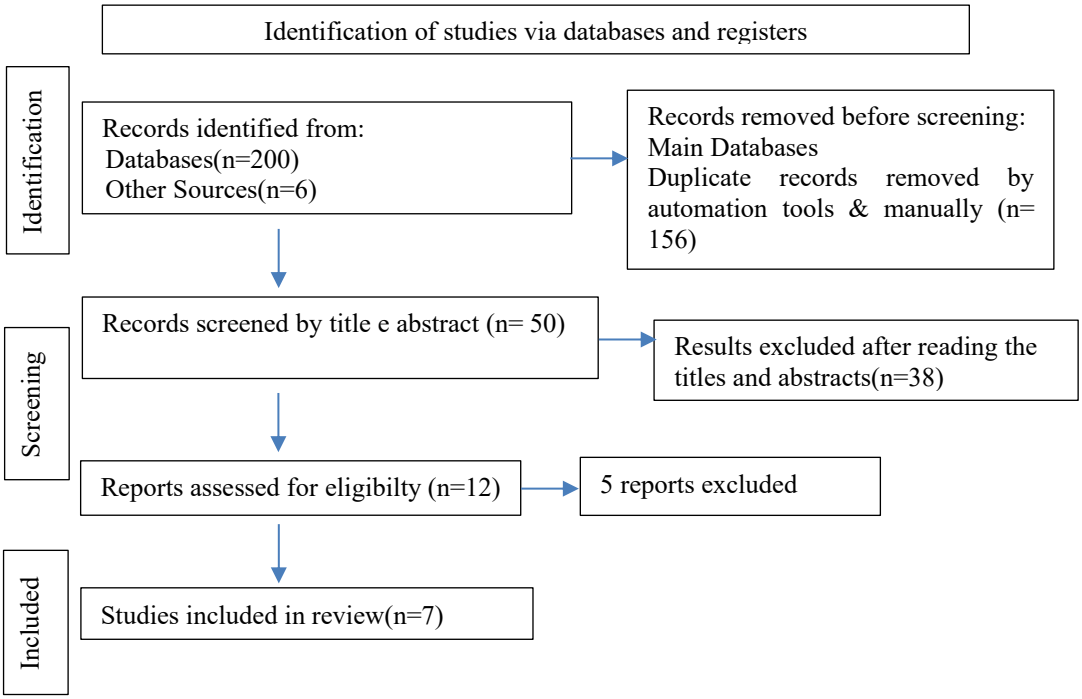

From the finally selected 7 articles, the following data was extracted: name of Author, Year of publication, Type of study, Age, Number of participants, Loss in Predictability, Efficacy using the pre treatment and posttreatment models

TABLE 3

Sr. No	Author	Year of Publication	Sample Size	Type of Study	Efficacy	Predictability	Age
1	Haylea L. Blundell et al[18]	December, 2024	102	Retrospective	Given in terms of percentage (%)	Given in terms of mean and SD	13.94 ± 1.53
2	Maurice J. Meade et al [9]	April, 2024	282	Retrospective	Given in terms of percentage (%)	Given in terms of mean and SD	>18yrs Years
3	Kang et al[15]	2024	15	Retrospective	Given in terms of percentage (%)	Given in terms of mean and SD	>18 Years
4	Nishat Shahabuddin et Al[16]	June 2023	24	Retrospective	Given in terms of percentage (%)	Given in terms of mean and SD	32.8± 11.9 yrs
5	Haylea Blundell et al [3]	November 2021	42	Retrospective	Given in terms of	Given in terms of mean and SD	>18 Years

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					percentage (%)		
6	Fontaine Sylvestre Catherine et al [4]	2019	60	Retrospective	Given in terms of percentage (%)	Given in terms of mean and SD	18-55 years
7	Elena Kreiger et al [17]	2012	50	Retrrospective	Given in terms of percentage (%)	Given in terms of mean and SD	33±11.19yrs

3. RESULTS

Efficacy and Loss in Predictability is written in terms of percentage and was taken directly from the articles, wherever mentioned. The articles where they did not mention it, it was calculated using the formula. Efficacy= (Actual outcome/ Predicted outcome) X 100, where actual outcome is difference between actual pre treatment overbite and post treatment overbite & predicted outcome is difference between software obtained pre treatment overbite measurement and post treatment overbite measurement.

Table 4 Efficacy

Author	**Efficacy**
Haylea L Blundell[18]	<14 yrs= 42.06% 14-17 yrs= 40.75 % Without G8 protocol= 40.35% Without G8 protocol=42.03% Without bite ramps= 44.88% With bite ramps= 35.39%
Maurice J. Meade[9]	NE: 45.83% E: 8.69%
Kang et al[15]	38.54%
Nishat Shahabuddin et al[16]	33.35%
Haylea Blundell et al [3]	39.2%
Fontaine Sylvestre Catherine et al[4]	37.67%
Elena Kreiger et al[17]	38.8%

Table 5 Loss in Predictability

Author	**Loss in predictability**
Haylea L Blundell et al[18]	<14 yrs= 57.94 % 14-17 yrs= 59.25% Without G8 protocol= 59.65% Without G8 protocol= 57.97% Without bite ramps= 55.12% With bite ramps= 64.61%
Maurice J. Meade[9]	NE: 54.17% E: 91.31%
Kang et al[15]	61.46%
Nishat Shahabuddin et al [16]	66.65%

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Haylea Blundell et al[3]	60.8%
Fontaine Sylvestre Catherine et al[4]	62.33%
Elena Kreiger et al [17]	61.2 %

TABLE 6 QUALITY ASSESSMENT OF THE ARTICLES

Sr. No.	Author	Study design (0-3)	Sample Size (0-1)	Sample description (0-2)	Error Analysis (0-1)	Statistical Analysis (0-2)	Quality Score (0-9)	Judged Quality Standard
1	Haylea L Blundell [18]	0	1	2	0	1	7	Medium
2	Maurice J. Meade[9]	0	1	1	0	2	6	Medium
3	Kang et al[15]	0	1	1	0	2	6	Medium
4	Nishat Shahabuddin et al[16]	0	1	1	0	2	6	Low
5	Haylea Blundell et al[3]	0	1	1	0	2	6	Medium
6	Fontaine Sylvestre Catherine et al [4]	0	1	1	0	2	6	Medium
7	Elena Kreiger et al[17]	0	1	1	0	2	6	Medium

From the above analysis of articles, it can be observed that efficiency of clear aligner therapy in correction of increased overbite is an average of 39.25%

4. DISCUSSION

Orthodontists now have access to revolutionary technologies for patient communication, There's a rise seen in the popularity of clear aligners because of it's esthetics, comfort and better oral hygiene maintenance. Clear aligners using 3 D computer imaging technology are specially crafted and customised to fit snugly over teeth. They use mild and controlled forces to align the teeth in their desired positions. There have been innovations and numerous tactics have been developed to ensure improved vertical control in deep bite malocclusions like pressure areas, optimised deep bite attachments and precision bite ramps. However, according to published research, despite of successful improvements in Clear aligner therapy in terms of material and composite resin attachment's design, clear aligner therapy has been unable to actually achieve whatever is virtually planned.[4]

The aim of this systematic review is to evaluate the discrepancy between expected and actual treatment outcome in correction of increased overbite with clear aligner therapy. It will help to devise a method so as to how to correct increased overbite with clear aligner therapy keeping in mind the vertical modifications or overcorrections required to develop an appropriate technique that will provide predicted, consistent and stable treatment outcomes. In order to prevent bias from normal vertical growth of jaws, an adult population was chosen to take part in the study. Dual arch orthodontic treatment was exclusively done using aligners so as to prevent any influence or bias by using fixed orthodontic therapy. In a study conducted by Kravitz et al, it was observed that one in every 6 patients switched from aligners to braces and an average of 2-3 refinement scans and 2years of treatment was required for all patients[14]. However, patients above 30 years were reluctant to shift to braces because of better esthetics thereby enhacing the need for aligners, therefore studies should be conducted to improvise the material and attachments thus, helping to bridge the gap between the expected and actual treatment outcome with clear aligner therapy.[4]

A retrospective study by Haylea L Blundell et al on 102 adolescent patients aged 10-17 years and found that the achieved overbite reduction of predicted was only 43%. There was no statistical difference in predictability

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between patients below 14 years and 14-17 years or between patients prescribed with G8 protocol and not or between patients given bite ramps and not. Therefore, it was concluded that there's very less influence of age, G8 protocol and bite ramps in the efficacy of overbite reduction with aligners in adolescent patients. [4]

A retrospective study conducted by Maurice J Meade et al with 282 adults found that the overjet achieved post treatment was nearly half of what was predicted whereas overbite was only 1/3rd of the expected overbite reduction. In the study it was found that the expected decrease in overbite was more challenging in extraction groups as compared to non extraction individuals. The accuracy for achieved overbite reduction in non extraction group was 45.83% to that of predicted whereas for extraction group it was 8.69% .[9]

Another study by Kang et al in which out of 20 patients, only 15 had overbite correction for complete deep bite and it was found that the accuracy for overbite reduction was 38.54% that of predicted. They also mentioned that despite of overcorrection and numerous refinement scans, correction of deep overbite still remains challenging with clear aligner therapy and hybrid treatment with fixed appliance should be taken into consideration.[15]

Nishat Shahabuddin et al in the study concluded 33.35% of accuracy for overbite reduction. It was in congruence to the study by Maurice J meade which also suggested overcorrections and mid course refinement scans in almost every patient[9,16]

Similar retrospective study by Haylea Blundell to find the discrepancy between expected and actual treatment outcome for correction of overbite found that clear aligner therapy could achieve only 39.2% of accuracy [3]

Likewise in a study carried out by Catherine Sylvestre et al, the software was unable to accurately predict the overbite correction. 37.67% of planned overbite correction had occurred using clear aligner therapy, It concluded that the study consiliences with the previous existing literature that the software overstates the actual occlusion achieved post treatment.[4]

Elena Kreiger et al conducted a study and found that the discrepancy between expected and actual treatment outcome are slightest in transverse(overjet) and saggital planes whereas larger deviations were seen for the movements in vertical direction. The accuracy for achieved overbite correction is 38.8% [17]

Despite recent successful advancements to clear aligner technology, there is still not enough scientific data or prospective studies to support the appliance's ability to correct the increased overbite correction as predicted by the software. The differences between expected and actual treatment outcome can also arise due to clinician's inexperience with the appliance, lack of patient compliance and software limitations. Therefore, further investigations and studies with better methodology are required to limit mid course corrections and refinements.

5. CONCLUSION

The systematic review reports that it is challenging to treat increase in overbite with clear aligner therapy as there is a discrepancy between expected and actual treatment outcome with it's average efficacy being 39.25% on the basis of the above searched articles. There is no prospective study in the existing published scientific literature to assess the efficacy of clear aligner therapy to correct the increased overbite thus, further investigations with improved study designs are required due to limited available evidence

Human and Animal Rights

No human rights were violated in the present study.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise

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