SYSTEMATIC REVIEW ON THE USE OF CLEAR ALIGNERS IN OGS CASES

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ABSTRACT:

With recent advances in orthodontics, clear aligners have become a popular treatment option for correcting various types of malocclusions. For certain severe skeletal cases involving non-growing patients, the treatment plan includes surgical correction in association with fixed orthodontic therapy. Thus, this systematic review focuses on the effectiveness and accuracy of clear aligners in correlation with orthognathic surgery.

There have been previous studies comparing the pre and post- surgical results of conventional appliances and clear aligners, it was observed that aligners have been on par or even better in producing the required results. When periodontal status and quality of life were assessed, clear aligners had a favorable effect and were preferred over conventional appliances. A few studies on surgical therapy combined with clear aligners showed improvement in esthetics and reduction in treatment time. Several authors advocate for further in-depth research, as the combination of advanced aligner technology with OGS(Orthognathic surgery) remains relatively unexplored.

This paper will talk about expanding the scope of aligners in orthognathic cases, and the benefits about the same.

KEYWORDS: orthognathic surgery, clear aligners, surgical orthodontics, systematic review, clinical efficiency, orthodontics, OGS

INTRODUCTION:

In orthodontics, clear aligners have become a popular treatment option for correcting various types of malocclusions. These are essentially customized removable devices that adapt over the tooth material and push them into proper positions. The

pursuit of innovation in this field is an indication as to how new and better innovations in orthodontically treating teeth are available.

The basic concept had evolved in the early 1970's to 1980's, there were usage of removable plastic appliances for minor movements of the teeth. Soon after which the exploration extended into Computer-Aided Design (CAD) technology that would be used to create custom aligners.

The clear aligner therapy experienced a log phase in popularity in the early 2010s, due to their advancements in the material biology, manufacturing techniques and digital workflows in the production. The companies started investing in artificial intelligence to help automate the treatment planning and simplify the manufacturing.

In the present day the clear aligners have become a convenient alternative to braces for the population. There is ongoing research in this field that aims at improving the treatment outcomes, treatment time and the scope of cases that could use clear aligners. There had been a remarkable transformation of clear aligners throughout history and the concept has evolved so much in the field of orthodontics that it can be considered to have a clear and promising future in the field of orthodontics.

This article focuses on the evolution of clear aligners and their effectiveness, while throwing light on the advancements in this field and usage of aligners in different orthodontic therapies.

MATERIALS AND METHODS:

Search strategy:

Two databases (Pubmed , Google scholar) were searched using medical subject headings (Mesh) from 1 January 2014 up to 30 October 2024. The search terms used were ((((((((((((clear aligners) OR (invisalign)) OR (transparent aligners)) OR (aligners)) AND (orthognathic surgery)) OR (mandibular advancement)) OR (mandibular setback)) OR (maxillary impaction)) OR (maxillary advancement)) OR (AMO)) AND (soft tissue)) AND (profile changes)) AND (orthodontic treatment)) OR (orthodontic therapy). A total of 2879 articles were finalized among which 9 articles were eligible for the literature review after full text reading.

Inclusion criteria:

Original articles on OGS and clear aligners, literature review articles, case series, case reports and articles about the effects of aligner therapy in surgical cases were included in the search.

Exclusion criteria:

Articles that were not available in English language, that were comments and letters to the editor, review articles and that which included either clear aligners or OGS solely were excluded.

Selection process:

Out of the articles that were identified from the databases, the duplicates were removed. The titles that were not relevant to the study were excluded from the review. Articles that were not retrievable and that were not related to the topic of interest were excluded. The PRISMA flowchart is as mentioned in Figure 1.

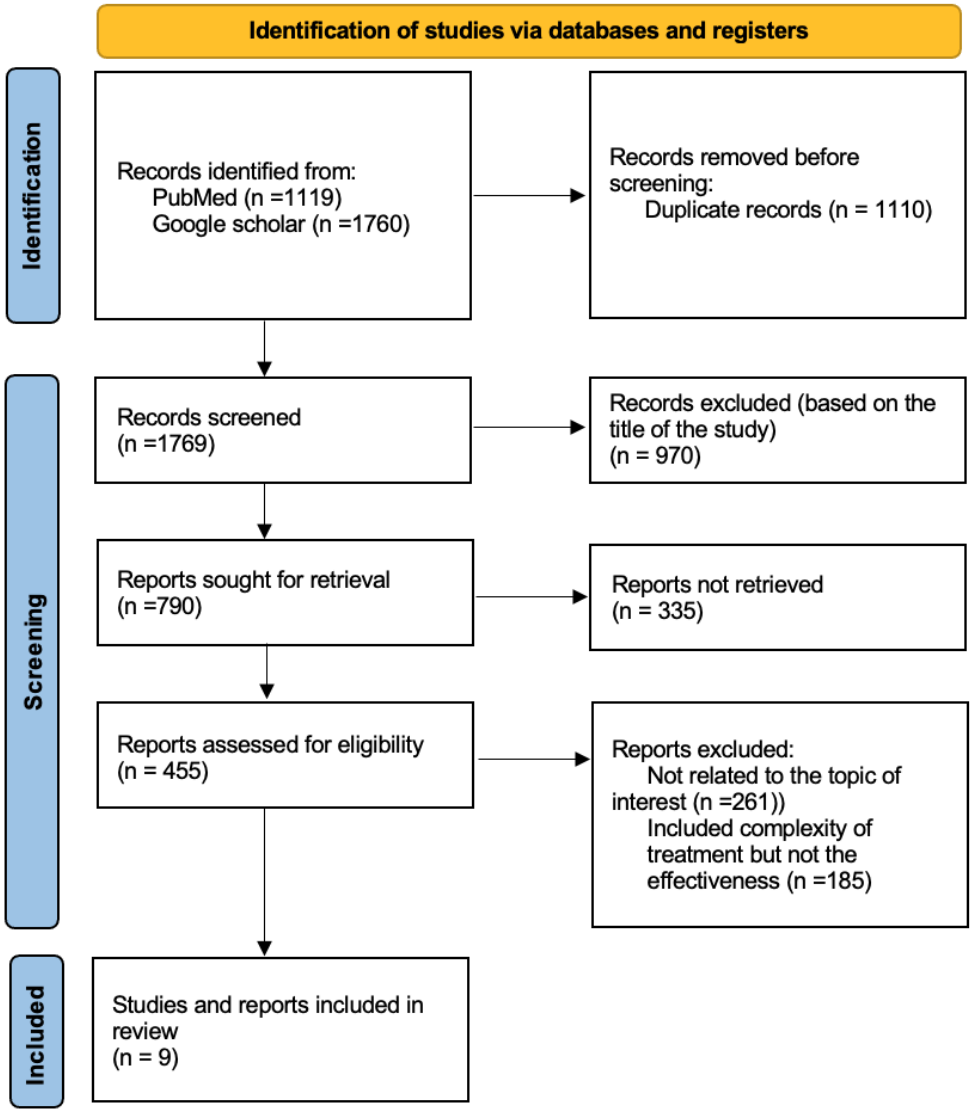

Figure 1: PRISMA Flowchart

Author, year	Condition	Study Design	Sample size	Statistically significant	Quality of study JADAD score	Magnitude of benefit	Absolute risk reduction	Number needed to treat	Comments
Maria Constanza Meazzini et al (2024)	Effectiveness of clear aligners in cleft patients needing Le Fort I osteotomies	Retrospective case series study	13 patients	P	P	Medium	NA	P	Blinding was not done and the patients were selected to be treated in a specific method
Amalia Cong et al (2023)	Analysing the amount of predicted tooth movement that occurred	Retrospective study	20 patients	Torque movements were statistically significant	P	Small	NA	P	No comments were provided on the randomization, blinding in the study; the study was elaborate in explaining the significant movement in each tooth in all 3 dimensions
Lei Kong et al (2022)	A case report of SFA accompanied by clear aligner therapy	Case report	1 patient	P	P	Medium	NA	P	The patient achieved a stable Class I occlusion with the combined treatment
Hee Kyun Ooh et al (2019)	A case report of orthognathic surgery	Case report	1 patient	P	P	Medium	NA	P	The patient achieved a quick profile change and fast tooth

	combined with aesthetic aligner therapy								alignment phase due to the use of clear aligners
Hadyn Kankam et al (2019)	Comparison between conventional appliance and clear aligners in orthognathic surgical cases	Retrospective study	33 patients	Not significant	P	NA	NA	P	The study shows similarities in the results obtained with both the appliances and indicates that the use of Invisalign in surgical cases is not to be contraindicated
Renato Pagani et al (2016)	A case report on therapy of Class III malocclusion using clear aligner therapy	Case report	1 patient	P	P	Small	NA	P	The patient had maintained a stable occlusion even after a 6 year follow up
Haddyn Kankam et al (2018)	Feasibility of double-jaw surgery per-formed using Invisalign	Case series	13 case reports	P	P	Medium	NA	P	The author commented on the advantages of using clear aligners and how fabrication of splint with the clear aligners is easy to use

Patricia de Leyva et al (2023)	To compare periodontal health and quality of life (QoL) associated to postsurgical orthodontic treatment.	Experimental study	28 patients	Periodontal status of the patients using Invisalign was statistically significant	1	Medium	P	P	The periodontal status of the patients who underwent surgery was the focus of the study
Tiantong Lou et al (2021)	Use of clear aligners as fixation devices after surgical procedure and maintenance of the same	Case report	2 case reports	P	P	Small	P	P	The patients showed good stability and fixation and clear aligners were an esthetic option for the orthodontic treatment

Table 1: Table of evidence. (Building an Evidence Table - Systematic Reviews in the Health Sciences - Research Guides at Rutgers University)

Author, year	Random sequence generation (Selection bias)	Allocation concealment (Selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selection reporting (reporting bias)	Overall risk of bias
Maria Constanza Mezzini et al (2024)	?	?	?	?	?	?	Unclear risk of bias
Amalia Cong et al (2023)	?	?	?	?	+	+	Low risk of bias
Lei Kong et al (2022)	_	_	_	_	_	_	High risk of bias
Hee Kyun Oh (2019)	_	_	_	_	_	_	High risk of bias
Hadyn Kankam et al (2019)	?	_	_	_	?	+	Unclear risk of bias
Renato Pagani et al (2016)	_	_	_	_	_	_	High risk of bias
Hadyn Kankam et al (2018)	?	?	?	?	NA	_	Unclear risk of bias
Patricia de Leyva et al (2023)	+	+	_	_	_	+	Low risk of bias
Tiantong Lou et al (2021)	?	?	?	?	?	?	Unclear risk of bias

Table 2: Risk of bias assessment. According to the Cochrane Hand book for Systematic Reviews of Interventions.

RESULTS:

Nine articles were selected for the systematic review (three retrospective studies, four case reports, one case series and one experimental study), and the risk of bias was low for two studies, unclear for four and high for the others.(Table 2) Clear aligners successfully performed common presurgical orthodontic movements, such as levelling and dental decompensation. The Surgery-First Approach (SFA) combined with clear aligners delivered quicker and more aesthetic results compared to traditional methods. The Invisalign group exhibited significantly better outcomes: lower bleeding on probing; reduced plaque index and decreased probing depth along with quality of life and treatment duration. Given the aesthetic and comfort advantages of clear aligners, they may be preferred by patients undergoing orthognathic surgery.(Table 3)

DISCUSSION:

Orthognathic surgeries have been performed since a long time. Bringing about a stable pre surgical result is the prerequisite to performing pre surgical orthodontics whether a fixed appliance is used or the clear aligners for that matter. The need for customized treatment planning and the potential complexity of certain surgical procedures highlight the importance of careful case selection and planning.

A. <u>INDICATIONS OF CLEAR ALIGNERS IN SURGICAL CASES:</u>

Clear aligners have emerged as a viable option in orthognathic surgery, particularly for pre-surgical and post-surgical orthodontics. Their application can enhance treatment outcomes by achieving necessary dental alignment before surgical intervention and refining occlusion afterward. The following sections detail the indications and effectiveness of clear aligners in this context.

Pre-Surgical Outcomes:

- Clear aligners can effectively prepare patients for surgery by achieving stable occlusion prior to the procedure, often requiring minimal refinement trays.[1]
- A study indicated that patients using clear aligners needed fewer impressions and refinement phases compared to those with fixed appliances, demonstrating efficiency in achieving pre-surgical alignment.[1]

Post-Surgical Outcomes:

- In a case series, patients who underwent orthognathic surgery with clear aligners reported satisfactory results without complications, highlighting the safety and effectiveness of this approach.[12]
- Clear aligners have shown comparable effectiveness to fixed appliances in managing skeletal malocclusions, with shorter treatment durations and fewer follow-up visits.[10,13]

While clear aligners present numerous advantages, some practitioners may still prefer traditional fixed appliances due to their established efficacy and predictability in complex cases. Nonetheless, the growing body of evidence supports the integration of clear aligners in orthognathic surgery protocols.

B. ADVANTAGES OVER TRADITIONAL BRACES:

With the advent of a better, aesthetic option there are chances for adults to opt for clear aligners. Clear aligners offer improved aesthetics during treatment compared to traditional braces.[9] Patients often prefer them due to their aesthetic appeal and the absence of metal components, which can improve compliance.[2] They are removable, allowing for better oral hygiene and reducing the risk of gingivitis compared to fixed appliances and contribute to a more positive patient experience.[12,11] The treatment can be flexible as the adjustment that are made in the aligners are tailored according to the stage the patient is in.

The clear aligners have shown improved accuracy of tooth movement as evidence from a study found that the average percentage accuracy of tooth movement was 63.4% ± 11.5%, higher than previously reported with certain movements like buccal torque and mesial displacement being particularly accurate.[2] While clear aligners are popular, the evidence supporting their efficacy and predictability in tooth movements is limited due to methodological issues in studies.[9] Advancements in digital planning using tools like ClinCheck help simulate tooth movements accurately, improving treatment planning and visualization.[2] The integration of clear aligners in surgical cases makes them versatile in orthodontic preparation for surgery as the treatment results are stable and achieved rapidly.

C. CHALLENGES AND LIMITATIONS:

Even with the advancing methods of treatment in orthodontics, each one of them has some limitations. With respect to clear aligners a few teeth like the molars showed low accuracy in buccal and intrusive movements. The aligners show maximum effect when worn regularly and so non- compliance leads to sub-optimal results and prolong the treatment duration.[2]

The use of clear aligners requires specific adjustments in treatment planning, such as the use of different occlusal splints and custom plating for maxilla-mandibular fixation. The primary challenge with clear aligners is the difficulty in localizing, mobilizing, positioning, and fixating the dentoalveolar complex and dental arches during surgery. The clear aligner orthognathic splint fits tightly, while it is beneficial for stability, it can pose challenges during the surgical procedure and postoperative care.[9]

Large fixation screws used in conjunction with clear aligners for fixation purpose and these can cause traumatic mucosal irritation for the first few weeks post-surgery. This discomfort can affect patient compliance, overall satisfaction and oral hygiene therefore increasing the complexity of the treatment planning and execution.[9]

There is a risk of overcorrection or overengineering in the treatment plan, which may not be accounted for in the final outcomes. This can lead to discrepancies between predicted and achieved tooth positions, potentially complicating the surgical process. The study mentioned that the software used for planning and simulating tooth movements can be time-consuming and may not always accurately predict final tooth positions. This limitation can hinder the effectiveness of treatment planning.[2]

D. THE ROLE OF TECHNOLOGY IN CLEAR ALIGNER TREATMENT PLANNING:

The use of computer-aided surgical simulation and intraoral scanning has significantly enhanced the planning and execution of orthognathic surgeries, facilitating a smoother transition in managing complex cases. There are studies that utilized the initial digital dental models and ClinCheck prediction models, to plan tooth movements before the actual tooth movement begins. Novel 3D superimposition techniques are

employed to evaluate the accuracy of tooth movement and ClinCheck, a virtual modelling software plays a vital role in treatment planning by predicting how teeth will move throughout the course of treatment.[2,3,4]

Materials like SmartTrack have been introduced to improve the accuracy of tooth movements and contribute to better treatment outcomes, particularly in arch levelling and decompensation. Recent studies have shown that 3D-printed surgical splints can effectively translate virtual treatment plans into surgical outcomes, which is a significant advancement in the field. [9] The integration of digital technology allows for precise planning and visualization of the tooth moments, enhancing the predictability and accuracy of the treatment.[3]

E. FUTURE DEVELOPMENTS IN CLEAR ALIGNER TECHNOLOGY:

Treatment with clear aligners prior to orthognathic surgery is not extensively discussed in the existing literature. Clear aligners are a practical alternative for presurgical orthodontic preparation, especially for patients prioritizing aesthetic solutions. Despite certain challenges, advancements in digital planning and custom surgical aids reinforce the feasibility of clear aligners in orthognathic cases. Further research is needed to evaluate the long-term stability and refine the criteria for utilizing the Surgery-First Approach (SFA), particularly for patients with more complex orthodontic conditions.

Author	Purpose	Type of study	Summary points
Maria Costanza Meazzini et al	To explore the potential of aligners, particularly in multiple-piece maxillary osteotomies	Retrospective study	It appears that clear aligner could serve as an effective treatment for individuals necessitating segmental Le Fort I osteotomies when aided by the suggested simple superimposition approach.
Amalia Cong et al	To evaluate the accuracy of tooth movements with clear aligners during presurgical orthodontics using novel 3D superimposition techniques	Retrospective study	The amount of predicted tooth movement was compared with the achieved amount for each movement and tooth by superimposing the initial, pre surgical digital dental models and clin check models.
Lei Kong et al	This case report introduces digital surgery-first approach orthognathic surgery assisted by three- dimensional virtual planning and combined with invisible orthodontic treatment for a 21-year-old female patient with a skeletal Class III high-angle gummy smile malocclusion	Case Report	A case involving SFA of Le Fort I, BSSO and genioplasty was treated with aligners post-surgery, it showed good results and stability.
Hee Kyun Oh et al	A case report that used aesthetic aligner therapy along with surgery first approach for the correction of a Class III malocclusion	Case report	The study showed the patient achieving the ideal occlusion after a combined therapy of using aligners in OGS cases.

Hadyn Kankam et al	The effects of treatment using conventional appliances and clear aligner therapy were assessed	Retrospective study	The study showed similar effects with regard to both the treatment modalities
Renato Pagani et al	A Class III patient was approached with a treatment plan involving surgical and clear aligner therapy	Case report	The patient achieved dental and skeletal symmetry corrections, occlusion and functional balance after going through surgery and Invisalign therapy.
Hadyn Kankam et al	This study reviews the feasibility of double-jaw surgery performed using Invisalign.	Case series	Segmental double-jaw surgery can be successfully performed without the need for conventional metal braces and arch wires . The trays are removable and patients do not require frequent orthodontic appointments for apparatus adjustment
Patricia de Leyva et al	To compare periodontal health and quality of life (QoL) associated to postsurgical orthodontic treatment.	Experimental study	The periodontal status and maintenance of the patients undergoing surgery was significantly better with the clear aligner group
Tiantong Lou et al	To present recommendations on the use of clear aligners in surgical cases and the digital workflow involved in designing a clear aligner splint for fixation after surgery	Case study	The use of clear splints were easy and simple and did provide good stability when used for fixation

Table 3: Overview of the studies.

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