Dental Research Journal

Review Article

# Combined treatment approach: A review of using clear aligners in orthognathic surgery procedures

**Atefe Ahmadvand[1], Hossein Ebrahimi[2], Zahra Amiri[2], Parisa Besharatizadeh[2]**

[1]Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran, [2]Department of Orthodontics, School of Dentistry, Shahed University of Medical Sciences, Tehran, Iran

## ABSTRACT

**Background:** Clear aligner therapy (CAT) was originally introduced for minor orthodontic corrections. However, with technological advances and increasing patient demands for esthetic and comfortable treatments, its application has expanded into more complex cases, including orthognathic surgery. This narrative review explores the use of clear aligners across all phases of orthognathic treatment, such as presurgical, surgical, and postsurgical.

**Materials and Methods:** The literature from 2000 to 2025 was analyzed, identifying 34 relevant studies.

**Results:** Findings indicate that CAT can effectively manage dentofacial deformities such as skeletal Class II and III malocclusions, open bites, and craniofacial anomalies when used pre- and/or postoperatively.

**Conclusion:** Clear aligners offer significant advantages in esthetics, oral hygiene, treatment comfort, and quality of life. The combination of surgery and CAT has been demonstrated to reduce treatment time and increase patient satisfaction without compromising skeletal stability. Although there are some limitations, such as concerns about relapse and aligner rigidity in early postoperative phases, the results of occlusal stability, periodontal health, and patient satisfaction are promising. The increasing use of CAT in orthognathic surgery cases, particularly in digitally driven interdisciplinary treatment plans, is supported by this review as an effective and patient-centered alternative to fixed appliances.

**Key Words:** Clear aligner therapy, digital orthodontics, orthognathic surgery, surgery-first approach, surgical splints

**Received:** 13-May-2025
**Revised:** 22-Jul-2025
**Accepted:** 03-Aug-2025
**Published:** 24-Sep-2025

**Address for correspondence:**
Dr. Hossein Ebrahimi, Department of Orthodontics, School of Dentistry, Shahed University of Medical Sciences, Tehran, Iran.
E-mail: dr.hosseinebrahimi@gmail.com

## INTRODUCTION

Fixed braces have been the orthodontic appliance of choice for over 100 years.[1] However, increasing patient demand for more esthetic and comfortable treatment options has driven interest in clear aligner therapy (CAT) in recent years. Despite growing popularity, the viability of clear aligners as a comprehensive alternative to fixed appliances remains a topic of ongoing investigation.[1,2] CAT involves custom-made transparent trays that apply gentle, controlled forces to move teeth. Its advantages – such as being nearly invisible, removable, and more comfortable – make it a popular choice for improved oral hygiene and dietary flexibility.[3] The development of CAT dates back to the 20th century, when dentists

Access this article online

**Website:** www.drj.ir
www.drjjournal.net
www.ncbi.nlm.nih.gov/pmc/journals/1480
**DOI:** 10.4103/drj.drj_251_25



**How to cite this article:** Ahmadvand A, Ebrahimi H, Amiri Z, Besharatizadeh P. Combined treatment approach: A review of using clear aligners in orthognathic surgery procedures. Dent Res J 2025;22:37.

first explored the use of transparent plastic trays to realign teeth. They discovered that a sequential set of slightly modified aligners could progressively shift teeth into their ideal positions.[4] Initially, CAT was designed to address only minor tooth misalignments. While some systems continue to be restricted to treating mild positional issues, others have expanded their scope to include more complex malocclusions.[5] Over the past two decades, it has become a significant tool in managing malocclusions.[6]

In addition, individuals (generally adults) undergoing orthognathic jaw surgery are desiring for a speedy, clear, or invisible means of correcting their aberrant jaw and malocclusion problem.[7] With the growing popularity of clear aligners, it was a natural progression to explore their application in orthognathic surgery (OS) cases. In the current literature, there is not much research on the use of clear aligners in conjunction with OS. One of the earliest reports, published in 2005, described a case where clear aligners were used during the preoperative and postoperative phases, but the patient was switched to conventional fixed appliances shortly before surgery.[8] Given the digital nature of clear aligners, planning for surgical movements may be virtually performed, allowing for an immediate understanding of decompensation and appropriate customization of movements and the appliance versus an analog process.[9] Application of these techniques in OS allows optimization of the scope of indications and may increase case acceptance for surgical patients seeking esthetic and minimally invasive orthodontic options.[10]

This study aims to investigate the capabilities of clear aligners in different stages of orthognathic surgery and to investigate their effectiveness and efficiency in this procedure.

## MATERIALS AND METHODS

From 2000 to 2025, related articles were searched using databases such as ScienceDirect, Scopus, PubMed, and Google Scholar. All studies, published through March 25, 2025, were included in the study. The search keywords used are shown in Table 1. Relevant articles in the topic and abstract were assessed and included in the study.

**Table 1: Mesh keywords and synonyms**

| No. | Mesh keywords |
|---|---|
| 1# | (“Orthognathic Surgery”[Mesh]) OR (“Surgery, Orthognathic”) AND (“Surgery First”[Mesh]) OR (“SFA”) OR (“surgery first orthognathic”) |
| 2# | (“clear aligner*”[Mesh]) AND (“Orthodontic Appliances, Removable”[Mesh]) OR (“aligner*[Mesh]”) OR (“clear aligner therapy”) OR (“Invisalign”) |
| 3# | 1# AND #2. |

## RESULTS

An initial search was conducted using MeSH terms and related synonyms across databases, including ScienceDirect, Scopus, PubMed, and Google Scholar, covering 2000–2025. A total of 492 studies were identified. After removing 133 duplicate records, 359 articles remained for the screening phase. During this stage, 325 articles were excluded following a review of their titles, abstracts, and full texts due to irrelevance to the research topic. Consequently, 34 studies met the inclusion criteria and were incorporated into the final review. These included 17 case reports, 7 case series, 4 case–control studies, 2 randomized controlled trials, 3 retrospective studies, and 1 comparative study. Studies excluded from the review were those unrelated based on title, abstract, or full-text content, as well as review articles, including systematic reviews.

The included studies included data that included variables such as author (s), year of publication, study design, number and age range of participants, type of skeletal deformity, surgical intervention method, use of CAT, and reported outcomes. This information is summarized and compared in Table 2.

## DISCUSSION

OS is a combined orthodontic and surgical procedure used to correct dentofacial deformities that cannot be managed with conventional orthodontic treatment alone, such as severe Class II or III malocclusions, anterior open bites, and facial asymmetries.[44] These discrepancies often significantly impact facial esthetics, occlusal function, and overall quality of life, and their correction can greatly enhance patient self-esteem and psychological well-being.[45] The most commonly performed surgical techniques in OS are LeFort I osteotomy and sagittal split ramus osteotomy (SSRO),[46,47] which aim to reposition the maxilla and mandible for improved functional and esthetic outcomes.

Surgical orthodontic treatment requires close coordination between orthodontists and maxillofacial

**Table 2: Overview of the characteristics, data extraction, and outcomes of the included studies**

| Authors (year) | Study design | *n* | Age | Type of malocclusion | Surgical method | Fixation (RIF and IMF) | Intervention | Outcomes |
|---|---|---|---|---|---|---|---|---|
| Boyd. (2005)[8] | CS | 2 | #1: 27, #2: 29 | Skeletal CLIII | Case#1: NR<br>Case#2: Maxillary advancement | #1: RIF<br>#2: RIF | #1: Invisalign Pre-op during the 4-month.<br>#2: 30 upper and 28 lower aligners, and refinement series used 16 upper and 12 lower aligners. Final detailing was carried out with fixed appliances | Effective when combined with segmental fixed appliances or before full fixed appliances, immediately before/ after surgery. |
| Pagani *et al.* (2016)[11] | CR | 1 | 23 | Skeletal CLIII | BSSO | Brackets + titanium plates | Invisalign system/ Pre-op: 19 upper and 9 lower aligners. For 10 months. Changed every 15 days<br>Post-op: 5 upper and lower aligners. The whole treatment required 12 months | Effective management of the orthodontic phases of OS with CATs |
| Kankam *et al.* (2019)[12] | CC | 15 | 19.9 | NR | SFA (Lefort I + BSSO) | Erich arch bars, TADs + SMART-Lock Hybrid MMF./Six 8mm TADs, the final splint is secured to the TADs, in 3 locations, with wires. | Invisalign system<br>Post-op CAT | Complex orthognathic procedures can be managed with CATs. |
| Chang *et al.* (2019)[13] | CR | 1 | 20 | Skeletal CLII + severe mandibular retrognathism | SFA | IMF was supplied by 8 TADs<br>CLII elastics were worn from the TADs for about 6 months after surgery. | Invisalign system/ Post-op: CAT began one month after surgery./18 upper and 19 lower aligners. | Effective alongside OS for aesthetic treatment options |
| Kook *et al.* (2019)[14] | CR | 1 | 20 | Mandibular prognathism | SFA (LeFort I + mandibular setback) | Thin acrylic surgical wafer. 4 TADs/Elastics were placed to stabilize the jaw position for 2 weeks | Post-op: 3 weeks after the surgery, postsurgical CAT. The patient used two aligners (soft and hard aligners) per week. | CAT facilitated rapid and aesthetic tooth movement |
| Amodeo *et al.* (2020)[15] | CS | 12 | NR | Severe CLIII | SFA | NA | Post-op CAT | Validity of use of SFA and CATs in the management of CLIII malocclusion |
| Azzuni *et al.* (2021)[16] | CR | 1 | NA | NA | SFA | IMF is carried out with the use of TADs. | Post-op. CAT | Effective in managing postsurgical orthodontic treatment with enhanced patient comfort |
| Lou and Caminiti (2021)[17] | CR | 2 | NR | CLIII | BSSO + segmental LeFort I advancement | TADs (9×1.5–1.85mm) are used for temporary MMF + subsequent elastic attachment. including II, III, or box, depending on the presurgical malocclusion. | Brackets bonded before surgery for temporary IMF, clear aligner splints | An effective approach for achieving IMF with precise positioning |

*Contd...*

**Table 2: Contd...**

| Authors (year) | Study design | *n* | Age | Type of malocclusion | Surgical method | Fixation (RIF and IMF) | Intervention | Outcomes |
|---|---|---|---|---|---|---|---|---|
| Iodice *et al.* (2021)[18] | CR | 1 | 21 | CLII malocclusion + mandibular retrusion | SFA: Impaction of the Maxilla, mandibular advancement, and chin surgery | Postsurgical IMF was obtained by elastics on TADs Elastics 23 h a day from the TADs to the lower buttons | CAT was initiated one month after surgery./17 Upper and 17 Lower aligners. | Highly effective for esthetic improvement in adult patients |
| Nguyen *et al.* (2021)[19] | CS | 13 | 16–38 years old | Various dentofacial deformities | SFA | IMF was supplied by eight TADs. elastics were worn from the TADs for about 1 month after the surgery. | Post-op CAT | CAT improves early patient satisfaction and quality of life |
| Moon *et al.* (2021)[20] | CC | 15 | 22.2±1.33 | Different types of deformities | LeFort I + BSSO/BSSO | IMF wire on 3 TADs in each quadrant. | Pre-op CAT | Provides similar stability to fixed appliances with shorter duration and fewer extractions |
| Kwon *et al.* (2023)[21] | RS | 15 | NR | Different types of deformities | NR | NR | Pre-op and post-op CAT | Significant occlusal improvement is shown by the PAR index |
| Kong *et al.* (2022)[22] | CR | 1 | 21 | Skeletal CLIII | SFA (LeFort I + BSSO) | NR | Post-op: CAT was designed in 26 steps | Enhances patient-centered surgical orthodontic treatment |
| Zhang and Yang (2022)[23] | CR | 1 | 19 | Skeletal CLIII | LeFort I + BSSO | Interim and final splints are being fixed to eight 8mm TADs | Invisalign system/ Pre- and post-op CAT | Effective when used with OS for orthodontic treatment |
| Guo *et al.* (2022)[24] | CR | 1 | NR | Skeletal CLIII | SFA | NA | Post-op CAT | Helps achieve full aesthetic satisfaction with SFA |
| Meuli *et al.* (2022)[25] | CR | 1 | 40 | Relapsed condylar hyperplasia | SFA | NA | Post-op CAT | CATs are chosen to minimize patient discomfort due to relapse |
| Cong *et al.* (2022)[26] | RS | 20 | NR | NR | NR | Erich bars, Ivy loops + TADs for intermaxillary elastics | Pre-op CAT with Invisalign, 27–130 clear aligners | Highly accurate in arch leveling and decompensation |
| Miranda *et al.* (2023)[27] | CS | 16 | 26.78 | CLII (56.25%) + mandibular retrognathism | Single-jaw (56.15%) | Orthodontic buttons + elastics were used for IMF | Pre- and post-op CAT | Good results with no damage during treatment |
| Bastidas-Castillo and Ramirez-Naranjo (2024)[28] | CR | 1 | 20 | CLII | SFA (BSSO) | NA | Post-op CAT | Effective in achieving satisfactory and stable results |
| Dastgir *et al.* (2024)[29] | CS | 5 | NR | Various types of deformities | NR | NR | Pre- and post-op CAT with Invisalign | Successful treatment outcomes for skeletal deformities |
| de Leyva *et al.* (2023)[30] | RCT | 28 | 26.5 | Different types of deformities | SFA (single jaw/ bimaxillary) | 4 TADs for single Jaw/8 TADs for segmentation | Invisalign system Post-op CAT Begins with the insertion of the first aligner within the initial 10 days following surgery | Better periodontal health and quality of life outcomes |

*Contd...*

**Table 2: Contd...**

| Authors (year) | Study design | *n* | Age | Type of malocclusion | Surgical method | Fixation (RIF and IMF) | Intervention | Outcomes |
|---|---|---|---|---|---|---|---|---|
| Zhou *et al.* (2024)[31] | CS | 30 | NR | Skeletal CLIII | Surgery-early approach | NR | Post-op CAT/ Early surgery was achieved after 7.71 months of presurgical orthodontics, on average | Enhances facial profile and functional occlusion. |
| Macrì *et al.* (2024)[32] | CS | 4 | 18-34 | Skeletal CLIII | Bimaxillary (#3) and BSSO (#1) | NR | Pre- and post-op CAT/ changed the aligner every 14 days and wore it for at least 22 h/day | No differences between fixed appliances and CATs. |
| Meazzini *et al.* (2024)[33] | CC | 26 | NR | Cleft lip and palate + Skeletal CLIII | Multi-segmental maxillary surgery | Patients were bonded preoperatively; fixation was done with splints, wires, and elastics | Invisalign system pre- and post-op CAT | Effective treatment for segmental LeFort I osteotomies |
| Meazzini *et al.* (2024)[34] | CC | 18 | NR | Cleft lip and palate + Skeletal CLIII | Multi-segmental LeFort I | Rigid IMF | Invisalign sample was treated pre-surgically for an average of 18.4±3 months (range 11–23) | Effective for craniofacial anomalies requiring segmental osteotomies |
| Xiao *et al.* (2024)[35] | RS | 15 | 19–30 | Skeletal CLIII | LeFort I Segmental | NA | Pre- and post-op CATs./The average preoperative treatment duration was 16.2±5.22 months, with 33.5 pairs of clear aligners | Reduces duration of pre-op. orthodontics with CATs |
| Susarla *et al.* (2024)[36] | CR | 1 | 19 | Congenital craniofacial deformities | SFA | NA | Post-op CATs | More effective than fixed appliance therapy for improving aesthetics and patient tolerance |
| Li *et al.* (2024)[37] | RCT | 74 | 24.62±3.8 | Skeletal CLIII | SFA | NR | Post-op CAT./ were worn for at least 20 hours per day and were replaced with the next pair every 10 days. | Combined SFA and CATs offer comparable stability and save time. |
| Liou *et al.* (2024)[38] | Comparative | 33 | NR | Congenital craniofacial deformities | SFA | NR | Post-op CAT | CAT shows better immediate results than fixed appliance therapy after OS |
| Lugli *et al.* (2024)[39] | CR | 1 | 18 | CLIII + lateral deviation of the mandible | Class III surgical approach | Surgical stabilization + RIF using titanium mini bone plates and screws was carried out | Pre- and post-op CAT/32 aligner stages for both the upper and the lower dental arches. | Long-term stability confirmed after 4 years |

*Contd...*

**Table 2: Contd...**

| Authors (year) | Study design | *n* | Age | Type of malocclusion | Surgical method | Fixation (RIF and IMF) | Intervention | Outcomes |
|---|---|---|---|---|---|---|---|---|
| Sefidroodi *et al.* (2024)[40] | CR | 1 | 21 | Skeletal CLIII | LeFort I | 8 TADs were placed for additional anchorage, IMF, and postoperative guidance | Pre- and post-op CAT/Aligners were changed initially every 5 days during the first 3 month-period postoperation, and thereafter every 7 days | Stable occlusal outcomes, with improved subjective and objective evaluations post-treatment. |
| Shino *et al.* (2025)[41] | CR | 1 | 18 | Skeletal open bite | SFA (segmented Le-Fort I) | Four TADs were placed during surgery for anchorage, IMF, and postoperative guidance | Clear aligner splints and post-op/CAT Total treatment duration was one year. | Satisfied with functional and aesthetic outcomes |
| Newman and Stewart (2025)[42] | CR | 1 | 25 | Maxillary hypoplasia with an absolute transverse deficiency + anterior open bite | SFA (Le-Fort I + BSSO + genioplasty) | RIF, transoral placement of prebent titanium reconstruction plates | Post-op CAT was initiated at 6 weeks post-op/ Total treatment time 4.5 months. | Shortened treatment time with CAT and SFA. |
| Lavrin and Lawrence (2025)[43] | CR | 2 | 29 and 23 | CLII + III asymmetry | NR | Fixation includes the use of surgical splints, TADs, plates, buttons, and aligners with elastics | Pre- and post-op CAT | Enhances the success of OS with CATs. |

NR: Not Reported, NA: Not Available; SSRO: Sagittal split ramus osteotomy; BSSO: Bilateral sagittal split osteotomy; SFA: Surgery-first approach; CAT: Clear aligner therapy; TAD: Temporary anchorage device; IMF: Intermaxillary fixation. RIF: Rigid internal fixation; CR: Case report; CS: Case series; CC: Case control; RCT: Randomized controlled trial; RS: Retrospective study

surgeons and often involves collaboration with other specialties throughout the diagnostic, treatment, and posttreatment phases.[48] A successful outcome depends on comprehensive planning and interdisciplinary communication. The orthodontic aspect of orthognathic cases is guided by a thorough understanding of malocclusion, particularly a differential diagnosis of its skeletal, dental, and facial components, as well as the limitations of current orthodontic approaches.[49]

To enhance the occlusion, orthodontic tooth movement is often started before surgery and continues afterward. In traditional protocols, fixed appliances are utilized to achieve this.[50] However, with the advancement of technology, clear aligners have emerged as a viable alternative. Their transparency, removability, and enhanced patient comfort make them especially appealing for individuals with high esthetic demands.[51] In orthognathic cases, the use of clear aligners requires meticulous planning for presurgical decompensation and postsurgical finishing.[52] As their material properties and clinical protocols have evolved, clear aligners have gained increasing popularity in orthodontic practices worldwide and are now considered a preferred treatment option in many cases.[53]

## Treatment steps of clear aligner therapy in orthognathic surgery

### *Presurgical preparation*

Presurgical orthodontic goals should be clearly defined early on and may not require full arch leveling or ideal occlusion, as this phase determines the extent of surgical movements [Figure 1].[54] It typically lasts 12–24 months and addresses issues such as crowding, decompensation, and arch coordination. However, prolonged treatment may lead to complications such as gingival issues, root resorption, occlusal dysfunction, and psychological stress due to a worsened facial profile.[55,56] By eliminating dental compensations, orthodontists reveal the true skeletal discrepancy, enabling accurate surgical planning and better outcomes.[57]

Recent advances in OS aim to reduce the duration of preoperative orthodontic treatment and incorporate three-dimensional (3D) technologies into surgical planning to enhance precision.[58] One of the

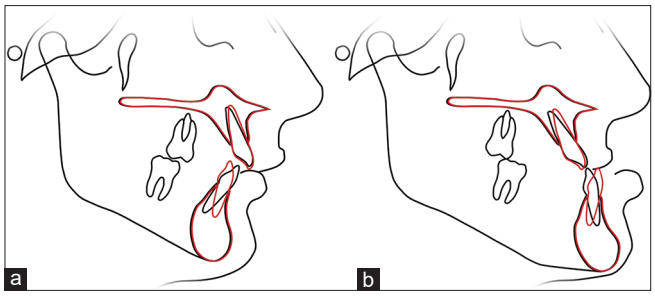


**Figure 1:** Presurgical preparation in orthognathic surgery patients. The dentoalveolar decompensation process aims to reveal the true skeletal discrepancy by eliminating compensatory tooth positions. The black lines represent the occlusal relationship before presurgical orthodontic treatment, while the red lines illustrate the corrected position after decompensation. (a) Class II patients; (b) Class III patients.

appliances that can be used in presurgical Preparation and decompensation is clear aligners.[11,21,24] Using clear aligners offers advantages such as reduced duration of preoperative orthodontics[35] and being an effective treatment.[8,11,34] Therefore, clear aligners can be considered a valid alternative for both pre- and postsurgical orthodontic treatment.[32]

### *Surgical treatment*

The orthodontist plays a key role in managing surgical-orthodontic treatment, especially during the preoperative phase, including arch preparation and creation of surgical splints.[59] While traditional OS uses brackets and wires for intraoperative splint stabilization, this is not possible with clear aligners.[23] For bimaxillary surgery, splints are used to achieve the final occlusion and stabilize the arches during healing.[60] In the clear aligner OS, tray splints are utilized, covering a greater portion of the dental crowns. Following surgery, clear aligners in combination with interarch elastics are used to maintain stability during the healing period. Unlike fixed appliances, clear aligners do not provide rigid fixation to the teeth; therefore, surgical management of the dentition and dental arches must follow a different protocol. Various fixation options are available, including bondable buttons, TADs, or a combination of both. Since interarch elastics require a stable point of anchorage, TADs are often essential during the presurgical phase to ensure adequate support.[61] The use of intermaxillary fixation screws facilitates precise surgical movements, accelerates the treatment timeline, and increases patient comfort.[62]

Clear aligners offer advantages such as precise seating of the dentition and quick fabrication through digital planning, although challenges such as high manufacturing costs and rigidity exist.[17] Clear aligner orthognathic splints provide full arch coverage, facilitating repositioning without wires.[17,41] Surgical splints are essential for stability in multisegmental surgeries, transverse stability, occlusal support when teeth are missing, and interdigitating occlusion in cases of worn or missing teeth.[63] The use of clear aligners in different types of OS is outlined below.

### Maxillary surgery

Significant advancements have made maxillary surgery a safe and effective method for correcting midface deformities. Landmark studies have demonstrated that manipulation and segmentalization of the maxilla are safe, establishing this procedure as a cornerstone of corrective jaw surgery.[64] Patients with skeletal disharmonies and complex craniofacial anomalies, requiring multisegmented LeFort I osteotomies or asymmetrical movements, often undergo a psychologically challenging phase of presurgical orthodontic decompensation and segmental preparation using multibracket orthodontics. In this context, CAT presents a promising alternative, offering the advantage of a more aesthetic appliance and the potential for fewer appointments.[33] In addition, Xiao *et al*. found that LeFort I segmental osteotomy aided in decompensating the upper anterior teeth and reduced the duration of preoperative orthodontics when clear aligners were used.[35]

### Mandibular surgery

Mandibular SSRO is a well-established procedure in craniomaxillofacial surgery, widely used to correct mandibular deformities such as retrusion, protrusion, deficiency, and asymmetry.[65,66] Its development marked a significant advancement in the field, as the technique allows broad bone contact for precise correction and effective spatial repositioning.[67] Boyd's case report demonstrated that Invisalign could be used effectively alongside segmental or full fixed appliances immediately before and after surgery, and that in certain cases, like single-jaw mandibular advancement or setback, surgery was completed without buccal fixed appliances.[8] Similarly, Pagani *et al*. showed that in Class III cases, Invisalign provided precise results, improved esthetics, better oral hygiene, and high patient satisfaction, along with functional occlusal rehabilitation.[11]

### Surgery first approach

The surgery-first approach (SFA) offers an alternative to conventional orthognathic protocols by

eliminating or minimizing the presurgical orthodontic decompensation phase.[30] In this method, most teeth remain in their original positions at the time of surgery, and the goal is to achieve a treatable malocclusion postoperatively. To ensure success, orthodontists must be actively involved in the surgical planning to confirm the feasibility of managing the resultant occlusion. The skeletal and dental discrepancies are largely corrected through osteotomy, which simplifies the subsequent orthodontic phase, typically requiring only anteroposterior adjustments and minimal transverse or vertical movements.[68]

SFA offers several advantages, including earlier improvements in facial esthetics and dental function, reduced treatment complexity and duration[37,69] and increased patient acceptance.[70] By bypassing the lengthy presurgical phase, patients experience immediate enhancement in facial profile and a shorter total treatment time, approximately 5 months less than with conventional approaches.[71] In addition, the postsurgical period is characterized by accelerated orthodontic tooth movement, which further reduces treatment time and difficulty.[72] Overall, the SFA is seen as a valuable and efficient alternative for managing complex dentofacial deformities.

### *Postsurgical finishing*

Effective postsurgical management is crucial for achieving stable and predictable outcomes in orthognathic–orthodontic treatment. The main goals are to refine occlusion, maintain stability, and ensure long-term retention.[63] Postoperative orthodontics typically lasts 5–11 months, with no clear link to presurgical treatment duration.[73] Intensive monitoring is needed in the first 1–2 months to adjust elastics or mechanics, followed by extended intervals once stability is achieved.[63]

A multidisciplinary approach is often required for final adjustments.[74] CAT can begin shortly after surgery if the arch form is stable, although it may be more difficult in cases requiring maxillomandibular fixation due to nonrigid mandibular osteotomies.[61]

### *Retention*

Retention in surgical orthodontic cases typically involves a Hawley or wraparound retainer for the maxillary arch, chosen based on whether the case involved extractions, and a fixed bonded lingual retainer from cuspid to cuspid in the mandibular arch. Although many patients prefer clear retainers, they are acceptable as long as they do not interfere with occlusion.[75] When appropriately used, clear aligners can also serve as effective retainers. However, in cases involving maxillary expansion, more rigid options such as Hawley retainers or full-palatal-coverage Essix retainers are recommended to maintain transverse corrections.[76]

## Evaluation of efficacy, outcomes, and patient-centered benefits

### *Efficacy and effectiveness*

Based on the results of various studies, the use of clear aligners in the presurgical or postsurgical preparation stages can be effective.[8,11-13,15,17,21,22,26,27,33,34,43] While the use of clear aligners in the pre- or post-surgical preparation stages was considered very effective in a study compared to a fixed appliance,[36] another study found no difference between removable and fixed appliances.[32]

Nevertheless, clear aligners can be considered an efficient approach for the combined orthodontic and surgical treatment of skeletal Class II/III patients.[13,39] On the other hand, clear aligners as splints during the surgical process are also effective.[17]

### *Oral Health-related Quality of Life*

The removability of clear aligners facilitates better oral hygiene practices, potentially supporting improved dental and periodontal health during orthodontic treatment.[77] A 2023 systematic review by Kaklamanos *et al*. reported that CAT may be linked to improved oral health-related quality of life (OHRQoL) compared to conventional labial metal fixed appliances.[78] However, other studies have suggested that CAT may have a lesser impact on OHRQoL compared to conventional fixed appliances during the 1st year of treatment.[79,80]

Compared to conventional fixed appliances, patients treated with clear aligners following OS using the SFA demonstrated improved periodontal health and quality of life outcomes.[30,81] De Leyva *et al*. also reported that postoperative CAT with Invisalign in SFA cases leads to better periodontal status and enhanced quality of life.[30] This improvement in periodontal health in SFA cases was confirmed by another study.[36]

### *Esthetic outcomes and patient satisfaction*

Patient satisfaction with CAT has been reported to be very high, primarily due to the invisibility of the treatment and functional rehabilitation of occlusion.[11] The combination of SFA with clear aligners increases esthetic satisfaction, improves clinical outcomes, and

reduces treatment time.[24] In addition, SFA treatment can enhance the facial profile, which is closely associated with increased patient satisfaction.[31,41] Studies have shown that clear aligners may be more effective than fixed orthodontic appliances in treating dental malocclusions.[17,29]

Due to their aesthetic and removable nature, clear aligners are considered a promising alternative to traditional orthodontics in OS,[26] as they eliminate the need for braces and wires[16] and reduce treatment time.[14,17,35,82]

### *Occlusal outcomes*

Clear aligners provide accurate 3D simulations for surgeons, essential for achieving optimal aesthetic and occlusal results in orthodontic–orthognathic combination treatment.[5] Kwon *et al*. found significant occlusal improvements with aligners, and orthognathic surgeries can be efficiently treated with them.[21] Zhou *et al*. demonstrated that early surgery for skeletal class III malocclusion improves facial profiles and functional occlusion with postoperative aligners.[31]

Li *et al*. confirmed that clear aligners offer similar skeletal stability to conventional methods.[37] Though some studies suggest that Invisalign cases may be more prone to relapse and that final occlusion can sometimes be less favorable, despite shorter treatment times.[83]

### *Skeletal stability*

The combined surgery-first and clear aligners treatment can achieve comparable skeletal stability to the conventional approach while also saving significant time.[37] The results of the Mangat *et al*. study demonstrate that skeletal relapse following OGS may not be affected by the mechanism of orthodontic therapy. Both fixed orthodontic appliances and CAT patients displayed minimal postoperative skeletal changes.[82] However, it is important to note that passive aligners may lack the necessary rigidity to adequately retain segmental movements in the immediate postoperative period.[84]

### *Pain level, muscle soreness, and postoperative edema*

While pain is a factor in orthodontic treatment, greater emphasis is often placed on predictability and technical outcomes, especially since pain differences tend to diminish after the initial months of treatment.[85] In the short term, CAT may cause mild tooth discomfort and masticatory muscle soreness, though these effects are generally limited. In addition, increased masticatory muscle soreness has been associated with frequent oral habits during CAT.[86] Almalki *et al*. reported that aligner-based orthodontic treatment can have varying effects on the masticatory muscles, often leading to an initial increase in symptoms that may improve over time.[87]

Patients that treated with Invisalign had significantly less facial swelling in the 1st postoperative week than those with fixed appliances.[88] In another approach described by Kankam *et al*., CAT was utilized in a complex triple-jaw OS (LeFort I osteotomy, bilateral sagittal split osteotomy, and genioplasty) case involving an Invisalign patient. The study found that perioperative outcomes and postoperative swelling were not significantly different compared to cases managed with traditional fixed appliances.[12] Based on the systematic review conducted by Rosenberg *et al*., it seems that CAT and fixed orthodontic treatment are comparable in facial swelling after OS.[89]

## CONCLUSION

CAT has emerged as a viable alternative to conventional fixed appliances in the context of OS. Multiple studies have confirmed its effectiveness in both presurgical and postsurgical orthodontic phases, demonstrating comparable skeletal stability and occlusal outcomes to traditional approaches. Clear aligners also contribute to shorter treatment durations in many cases, particularly with the SFA. Esthetic benefits, improved patient satisfaction, and better oral hygiene maintenance are notable advantages. Studies also show enhanced OHRQoL and periodontal outcomes in patients treated with CAT compared to those with fixed appliances. Despite these advantages, limitations remain. Passive aligners may lack the rigidity needed to retain segmental movements in the immediate postoperative phase. Some studies indicate a higher tendency for relapse due to the tipping movement mechanics of aligners. Moreover, while short-term discomfort, such as tooth pain or muscle soreness, is generally mild, aligner treatment does not significantly reduce long-term postoperative pain compared to fixed appliances.

Overall, CAT offers a highly aesthetic, patient-friendly, and efficient alternative for managing orthodontic-surgical cases, without compromising treatment quality or stability. With continuous advancements in digital planning and materials, its role in OS is expected to grow further.

Although attempted to cover a wide range of relevant studies by searching major databases, there is still a

need for research with larger, randomized populations. Future research could also use standardized methods and a wider range of databases to conduct systematic reviews, providing stronger and more reliable evidence.

### Declaration of AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used ChatGPT to improve readability and language. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

### Financial support and sponsorship

Nil.

### Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

## REFERENCES

1. Ke Y, Zhu Y, Zhu M. A comparison of treatment effectiveness between clear aligner and fixed appliance therapies. BMC Oral Health 2019;19:24.
2. Zheng M, Liu R, Ni Z, Yu Z. Efficiency, effectiveness and treatment stability of clear aligners: A systematic review and meta-analysis. Orthod Craniofac Res 2017;20:127-33.
3. Rossini G, Parrini S, Castroflorio T, Deregibus A, Debernardi CL. Efficacy of clear aligners in controlling orthodontic tooth movement: A systematic review. Angle Orthod 2015;85:881-9.
4. Lou T, Mair A. An Historical Overview of Clear Aligner Therapy the Evolution of Clear Aligners. Oral Health Group; 2020. p. 14.
5. Weir T. Clear aligners in orthodontic treatment. Aust Dent J 2017;62 Suppl 1:58-62.
6. Moshiri M. Product review and demonstration of the Invisalign clear aligner system. AJO DO Clin Companion 2021;1:7-21.
7. Chng C, Gandedkar N, Liou E. Diagnosis and Treatment Planning of Surgery-First Orthognathic Approach; 2019. p. 7-14.
8. Boyd RL. Surgical-orthodontic treatment of two skeletal Class III patients with Invisalign and fixed appliances. J Clin Orthod 2005;39:245-58.
9. Alkhayer A, Piffkó J, Lippold C, Segatto E. Accuracy of virtual planning in orthognathic surgery: A systematic review. Head Face Med 2020;16:34.
10. Taub D, Palermo V. Orthognathic surgery for the Invisalign patient. Seminars in Orthodontics 2016;23:99-102.
11. Pagani R, Signorino F, Poli PP, Manzini P, Panisi I. The use of invisalign® system in the management of the orthodontic treatment before and after class III surgical Approach. Case Rep Dent 2016;2016:1-10.
12. Kankam H, Madari S, Sawh-Martinez R, Bruckman KC, Steinbacher DM. Comparing outcomes in orthognathic surgery using clear aligners versus conventional fixed appliances. J Craniofac Surg 2019;30:1488-91.
13. Chang J, Steinbacher D, Nanda R, Uribe F. "Surgery-First" approach with invisalign therapy to correct a class ii malocclusion and severe mandibular retrognathism. J Clin Orthod 2019;53:397-404.
14. Kook MS, Kim HM, Oh HK, Lee KM. Clear aligner use following surgery-first mandibular prognathism correction. J Craniofac Surg 2019;30:e544-7.
15. Amodeo G, Meuli S, Carboni A, Brugnami F, Marrocco S, Orsini R, *et al*. Surgery first and invisalign system: Combined digital approach. J Craniofac Surg 2020;31:1681-6.
16. Azzuni C, Moro A, Saponaro G, Gasparini G, Soverina D, Barbera G, *et al*. Patient first: Surgery first and more. J Craniofac Surg 2021;32:e751-4.
17. LouT, Caminiti M. Orthognathic surgery combined with clear aligner therapy. J Clin Orthod 2021;55:44-58.
18. Iodice G, Tartaro G, Santagata M, D'Amato S. Full digital surgery-first, skeletal anchorage and aligners approach to correct a gummy smile and Class II malocclusion with mandibular retrusion and deviation. Appl Sci 2021;11:9985.
19. Nguyen MT, Vu TT, Nguyen QN. Advanced digital 3D technology in the combined surgery-first orthognathic and clear aligner orthodontic therapy for dentofacial deformity treatment. Processes 2021;9:1609.
20. Moon C, Sándor GK, Ko EC, Kim YD. Postoperative stability of patients undergoing orthognathic surgery with orthodontic treatment using clear aligners: A preliminary study. Appl Sci 2021;11:11216.
21. Kwon T, Alshehri A, Palo L, Kuo CL, Mu J, Blanck N, *et al*. Assessment of the occlusal outcomes in patients treated with orthognathic surgery and clear aligners. Orthod Craniofac Res 2023;26:371-7.
22. Kong L, Liu X, Zhang J. Combining a digital design-mediated surgery-first approach and clear aligners to treat a skeletal Class III defect for aesthetic purposes: A case report. J Int Med Res 2022;50 (4):1-14.
23. Zhang W, Yang H. Orthognathic surgery in invisalign patients. J Craniofac Surg 2022;33:e112-3.
24. Guo X, Jiang C, Liu X, Wang Z. Surgery-first treatment of a skeletal Class III malocclusion with a completely digital workflow. Int J Comput Dent 2022;25:201-19.
25. Meuli S, Amodeo G, Marrocco S, Brugnami F, Scopelliti D. Surgery first and clear aligners on relapsed condylar hyperplasia. J Craniofac Surg 2022;33:e60-5.
26. Cong A, Ruellas AC, Tai SK, Loh CT, Barkley M, Yatabe M, *et al*. Presurgical orthodontic decompensation with clear aligners. Am J Orthod Dentofacial Orthop 2022;162:538-53.
27. Miranda SL, Oliveira MR, Cheim Júnior AP, Moreno R, Miranda MV, Barbosa RL. Clear aligners combined with orthognathic surgery: A case series. Gen Dent 2023;71:66-70.
28. Bastidas-Castillo DA, Ramirez-Naranjo P. Surgery first with clear aligners for a Class II patient: Case report and literature review. J Stomatol Oral Maxillofac Surg 2024;125:101672.
29. Dastgir R, Bemudez PF, Valiathan M, Baur DA, Quereshy FA. The use of clear aligners in orthognathic surgeries: A case series. Oral Surg Oral Med Oral Pathol Oral Radiol 2024;137:e22-40.
30. De Leyva P, Eslava JM, Hernández-Alfaro F, Acero J. Orthognathic surgery and aligners. A comparative assessment of

periodontal health and quality of life in postsurgical orthodontic treatment with aligners versus traditional fixed appliances: A randomized controlled trial. Med Oral Patol Oral Cir Bucal 2023;28:e208-16.
31. Zhou G, Yu F, Yu H, Xia L, Yuan L, Fang B. Treatment of skeletal class III malocclusion using a combined clear aligner and surgery-early approach: Assessment based on the American board of orthodontics objective grading system. J Orofac Orthop 2024;85:359-67.
32. Macrì M, Alhotan A, Galluccio G, Barbato E, Festa F. Enhancing surgical outcomes via three-dimensional-assisted techniques combined with orthognathic treatment: A case series study of skeletal class iii malocclusions. Appl Sci 2024;14:3529.
33. Meazzini MC, Demonte LP, Cohen N, Battista VM, Rabbiosi D, Autelitano L. The use of clear aligners in multi-segmental maxillary surgery: A case-control study in cleft lip and palate and skeletal class III patients. J Clin Med 2024;13:1329.
34. Meazzini MC, Demonte LP, Autelitano L. Segmental maxillary osteotomy in cleft lip and palate patients: A stepwise planning in the orthodontic pre-surgical preparation with Invisalign. Eur J Paediatr Dent 2024;25:224-9.
35. Xiao X, Wu Z, Yeweng S. The efficiency of segmental le fort i surgery in clear aligner therapy of skeletal class III deformity: A pilot study. J Craniofac Surg 2024;35:e341-5.
36. Susarla SM, Sheller B, Kapadia H. Discussion: Comparative assessment of orthodontic and aesthetic outcomes after orthognathic surgery with clear aligner or fixed appliance therapy. Plast Reconstr Surg 2024;154:173-4.
37. Li M, Shen S, Huang J, Wang Y, Bao J, Wang B, *et al*. The skeletal stability of combined surgery first approach and clear aligners in skeletal class III malocclusion correction: A randomized controlled trial. J Clin Med 2024;13:872.
38. Liou YJ, Chen PR, Tsai TY, Lin S, Chou PY, Lo CM, *et al*. Comparative assessment of orthodontic and aesthetic outcomes after orthognathic surgery with clear aligner or fixed appliance therapy. Plast Reconstr Surg 2024;154:162-72.
39. Lugli L, De Razza FC, Loberto S, Cozza P. The use of clear aligners in the management of the orthodontic treatment before and after Class III surgical approach. Annali di Stomatologia 2024;15:155-65.
40. Sefidroodi M, Shino IL, Vassis S, Hammer KE, Kristensen KD, Pedersen TK, *et al*. Surgery First and Aligners: A case report combining in-house surgical guides and pre-adapted titanium plates. Appl Sci 2024;14:10374.
41. Shino IL, Sefidroodi M, Vassis S, Kristensen KD, Pedersen TK, Buhl J, *et al.* Integrating aligners with surgery first: A novel case report on single-jaw, multi-segmented maxillary osteotomy. Oral Maxillofac Surg Cases 2025;11:100392.
42. Newman MF, Stewart J. Management of the anterior open bite using clear aligner therapy and surgery-first: Case example and scoping review of the literature. Dent Rev 2025;5:100153.
43. Lavrin I, Lawrence S. Clear aligner treatment with orthognathic surgery. Semin Orthod 2025;22(44):1-17.
44. Cunningham SJ, Johal A. Orthognathic correction of dento-facial discrepancies. Br Dent J 2015;218:167-75.
45. Khechoyan DY. Orthognathic surgery: General considerations. Semin Plast Surg 2013;27:133-6.
46. Dos Santos VD, Queiroz SI, da Silva AC, Silva S, da Silva JS, Fernandes GV, *et al*. Evaluation of the anatomic position of the mandibular canal regarding to the segments of the mandibular sagittal split ramus osteotomy to diminish the possibility of injuries: A pilot study. J Oral Maxillofac Res 2022;13:e2.
47. Buchanan EP, Hyman CH. LeFort I osteotomy. Semin Plast Surg 2013;27:149-54.
48. Kau CH, Soh J, Christou T, Mangal A. Orthodontic aligners: Current perspectives for the modern orthodontic office. Medicina (Kaunas) 2023;59:1773.
49. Zhao ZH. Clear aligner therapy: Risks and clinical strategies. Zhonghua Kou Qiang Yi Xue Za Zhi 2019;54:798-802.
50. Park JH, Papademetriou M, Kwon YD. Orthodontic considerations in orthognathic surgery: Who does what, when, where and how? Seminars in Orthodontics 2016;22:2-11.
51. Hohoff A, Joos U, Meyer U, Ehmer U, Stamm T. The spectrum of Apert syndrome: Phenotype, particularities in orthodontic treatment, and characteristics of orthognathic surgery. Head Face Med 2007;3:10.
52. Yuan H, Zhu X, Lu J, Dai J, Fang B, Shen SG. Accelerated orthodontic tooth movement following le fort I osteotomy in a rodent model. J Oral Maxillofac Surg 2014;72:764-72.
53. Sabouni W, Gandedkar NH, Vaid NR. Clinical application of Clear Aligner Treatment (CAT) in the Surgery-First Orthognathic Approach (SFOA). Seminars in Orthodontics 2022;28:334-46.
54. Larson BE. Orthodontic preparation for orthognathic surgery. Oral Maxillofac Surg Clin North Am 2014;26:441-58.
55. Mahmood HT, Ahmed M, Fida M, Kamal AT, Fatima F. Concepts, protocol, variations and current trends in surgery first orthognathic approach: A literature review. Dental Press J Orthod 2018;23:36.e1-6.
56. Luther F, Morris DO, Hart C. Orthodontic preparation for orthognathic surgery: How long does it take and why? A retrospective study. Br J Oral Maxillofac Surg 2003;41:401-6.
57. Rossi O, Perrotti G, Del Fabbro M, Testori T. Novel parameter in pre-surgical orthodontic preparation: A retrospective study on the role of the upper incisor position and a morphological evaluation of the anterior Nasal Spine. J Clin Med 2024;13:2346.
58. Seo HJ, Choi YK. Current trends in orthognathic surgery. Arch Craniofac Surg 2021;22:287-95.
59. Dahan S, Le Gall M, Julié D, Salvadori A. New protocols for the manufacture of surgical splints in surgical-orthodontic treatment. Int Orthod 2011;9:42-62.
60. Posnick JC, Kinard BE. Is a final splint necessary in bimaxillary orthognathic surgery? J Craniofac Surg 2020;31:1756-9.
61. Aziz SR. Clear aligner orthognathic surgery: An overview. Front Oral Maxillofac Med 2021;4:1-5.
62. Golabkesh Afshar A, Samieirad S, Shiezadeh I, Alizadeh O, Moradpour A, Aboutorabzadeh SH, *et al*. Intermaxillary Fixation Screws (IMF) and surgery first approach: A novel combination and case report. World J Plast Surg 2024;13:104-10.
63. Wolford LM. Comprehensive post-orthognathic surgery orthodontics: Complications, misconceptions, and management. Oral Maxillofac Surg Clin North Am 2020;32:135-51.
64. Bauer RE 3rd, Ochs MW. Maxillary orthognathic surgery. Oral Maxillofac Surg Clin North Am 2014;26:523-37.

65. He Y, Zhang H, Qiao J, Fu X, Xu S, Jin Q, *et al*. Biomechanical evaluation of seven fixation methods for sagittal split ramus osteotomy with four advancement levels by finite element analysis. Front Surg 2022;9:891747.
66. Reyneke JP, Ferretti C. The Bilateral sagittal split mandibular ramus osteotomy. Atlas Oral Maxillofac Surg Clin North Am 2016;24:27-36.
67. Singh H, Srivastava D, Kapoor P, Sharma P. Surgical orthodontic correction of mandibular laterognathism. J Orthod Sci 2016;5:74-80.
68. Huang CS, Chen YR. Orthodontic principles and guidelines for the surgery-first approach to orthognathic surgery. Int J Oral Maxillofac Surg 2015;44:1457-62.
69. Strohl AM, Vitkus L. Surgical orthodontics. Curr Opin Otolaryngol Head Neck Surg 2017;25:332-6.
70. Yu HB, Mao LX, Wang XD, Fang B, Shen SG. The surgery-first approach in orthognathic surgery: A retrospective study of 50 cases. Int J Oral Maxillofac Surg 2015;44:1463-7.
71. Uribe FA, Farrell B. Surgery-first approach in the orthognathic patient. Oral Maxillofac Surg Clin North Am 2020;32:89-103.
72. Liou EJ, Chen PH, Wang YC, Yu CC, Huang CS, Chen YR. Surgery-first accelerated orthognathic surgery: Orthodontic guidelines and setup for model surgery. J Oral Maxillofac Surg 2011;69:771-80.
73. Luther F, Morris DO, Karnezi K. Orthodontic treatment following orthognathic surgery: How long does it take and why? A retrospective study. J Oral Maxillofac Surg 2007;65:1969-76.
74. Brunel JM. Finishing procedures in orthodontic-surgical cases. Int Orthod 2015;13:332-69.
75. Hirschhaut M, Flores-Mir C. Guidelines for orthodontic evaluation and preparation for orthognathic surgery patients. Compend Contin Educ Dent 2022;43:82-8.
76. Moshiri M. Considerations for treatment of patients undergoing orthognathic surgery using clear aligners. AJO DO Clin Companion 2022;2:229-39.
77. Rouzi M, Zhang X, Jiang Q, Long H, Lai W, Li X. Impact of clear aligners on oral health and oral microbiome during orthodontic treatment. Int Dent J 2023;73:603-11.
78. Kaklamanos EG, Makrygiannakis MA, Athanasiou AE. Oral health-related quality of life throughout treatment with clear aligners in comparison to conventional metal fixed orthodontic appliances: A systematic review. Int J Environ Res Public Health 2023;20:3537.
79. Jaber ST, Hajeer MY, Burhan AS, Latifeh Y. The effect of treatment with clear aligners versus fixed appliances on oral health-related quality of life in patients with severe crowding: A one-year follow-up randomized controlled clinical trial. Cureus 2022;14:e25472.
80. Sauer MK, Drechsler T, Peron PF, Schmidtmann I, Ohlendorf D, Wehrbein H, *et al*. Aligner therapy in adolescents: First-year results on the impact of therapy on oral health-related quality of life and oral hygiene. Clin Oral Investig 2023;27:369-75.
81. Li Q, Du Y, Yang K. Comparison of pain intensity and impacts on oral health-related quality of life between orthodontic patients treated with clear aligners and fixed appliances: A systematic review and meta-analysis. BMC Oral Health 2023;23:920.
82. Mangat H, Caminiti M, Metaxas A. A comparative analysis of orthognathic surgical stability between fixed appliances and clear aligner orthodontic therapy. J Oral Maxillofac Surg 2021;79:e83-e4.
83. Kassam SK, Stoops FR. Are clear aligners as effective as conventional fixed appliances? Evid Based Dent 2020;21:30-1.
84. Kierce J, Caminiti M. Retention strategies for segmental lefort I osteotomies using clear aligners. J Craniofac Surg 2023;34:1061-3.
85. Cardoso PC, Espinosa DG, Mecenas P, Flores-Mir C, Normando D. Pain level between clear aligners and fixed appliances: A systematic review. Prog Orthod 2020;21:3.
86. Tran J, Lou T, Nebiolo B, Castroflorio T, Tassi A, Cioffi I. Impact of clear aligner therapy on tooth pain and masticatory muscle soreness. J Oral Rehabil 2020;47:1521-9.
87. Almalki SA, Al Jameel AH, Gowdar IM, Langaliya A, Vaddamanu SK, Di Blasio M, *et al.* Impact of clear aligner therapy on masticatory musculature and stomatognathic system: A systematic review conducted according to PRISMA guidelines and the Cochrane handbook for systematic reviews of interventions. BMC Oral Health 2024;24:350.
88. Guntaka PK, Kiang K, Caprio R, Parry GJ, Padwa BL, Resnick CM. Do patients treated with Invisalign have less swelling after orthognathic surgery than those with fixed orthodontic appliances? Am J Orthod Dentofacial Orthop 2023;163:243-51.
89. Rosenberg SA, Rossouw PE, Barmak BA, Michelogiannakis D, Javed F. Comparative evaluation of postoperative facial swelling and occlusion in orthognathic treatment with clear aligners versus fixed orthodontic appliances: A systematic review. Appl Sci 2023;13:11675.