Original Article

Postsurgical stability in mandibular prognathism patients undergoing a surgery-first approach: influence of postoperative orthodontic approach using clear aligners vs fixed appliances

Kyungmin Clara Lee[a]

ABSTRACT

Objectives: To compare the effect of postsurgical orthodontic treatment between using clear aligners (CA) or fixed appliances (FA) on the postsurgical stability of patients with mandibular prognathism in the surgery-first approach (SFA).

Materials and Methods: This retrospective study included 54 patients with mandibular prognathism who underwent surgical orthodontic treatment with isolated mandibular setback surgery. The patients were divided into two groups according to the mechanics of postsurgical orthodontic treatment: the CA group included 27 patients treated with clear aligners, and the FA group included 27 patients treated with brackets during postoperative orthodontic treatment. Cone beam computed tomography scans were taken before, immediately after, and at 3, 6, and 12 months postsurgery to assess mandibular relapse. The measurements of postsurgical mandibular relapse including horizontal and vertical positions were compared according to the treatment progress and groups.

Results: Total postsurgical mandibular relapse at pogonion was 3.2 mm in the CA group and 2.2 mm in the FA group. Relapse was higher at 3 months postsurgery in both groups, with an average forward movement of 1.4 mm in the CA group and 1.7 mm in the FA group. Relapse in the CA group showed no significant changes over time, indicating persistence beyond the initial period. In contrast, the FA group showed a significant reduction in relapse by 3 months. Overall, the CA group tended to have greater and more persistent relapse than the FA group.

Conclusions: Careful consideration of skeletal relapse is needed in the postsurgical management of patients treated with clear aligners in SFA treatment. (*Angle Orthod*. 2026;00:000–000.)

KEY WORDS: Postsurgical stability; Mandibular prognathism; Surgery-first approach; Clear aligners

INTRODUCTION

Implementation of the surgery-first approach (SFA) in orthognathic surgical protocols has altered the management of patients with dentofacial skeletal deformities.[1,2] Unlike conventional orthognathic surgery (COS), the SFA eliminates the presurgical orthodontic treatment phase and facilitates immediate resolution of the skeletal and soft tissue imbalance, followed by orthodontic tooth movement.[2–4] In addition, remodeling and turnover of the alveolar bone accelerate postsurgical orthodontic treatment, shortening treatment time.[4,5] However, the implementation of the SFA raises questions regarding surgical stability, especially concerning the specific orthodontic appliances utilized. The etiology of skeletal relapse in orthognathic surgery is multifactorial, involving factors such as surgical technique, bone healing, and postsurgical orthodontic management. The role of differing orthodontic mechanics, such as fixed appliances vs clear aligners, in relapse has not been thoroughly evaluated. This is important due to the rising utilization rates of clear aligner therapy in surgical-orthodontic cases. Clear aligners offer several benefits, including improved esthetics, comfort, and oral hygiene, compared to traditional fixed appliances. However, their efficacy in providing sufficient force and control for complex tooth movement

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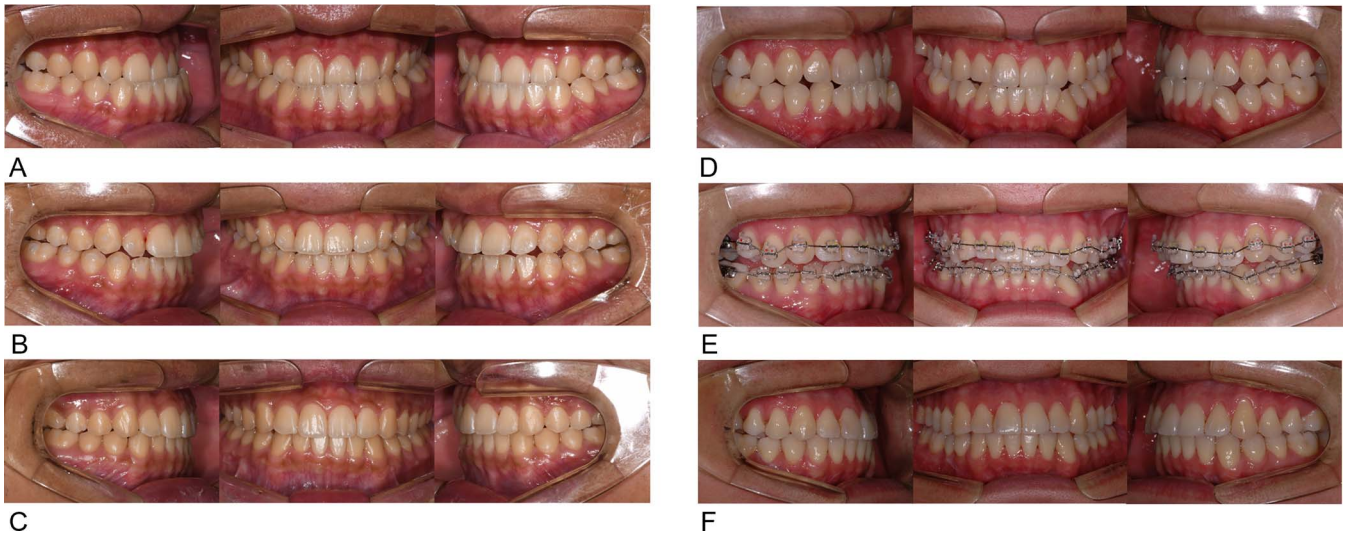

Figure 1. Intraoral photos in the clear aligner treatment group (A, B, C) and fixed appliance treatment group (D, E, F). (A) Before treatment; (B) 3 weeks after surgery; (C) after treatment; (D) before treatment; (E) 3 weeks after surgery; (F) after treatment.

postsurgery remains unknown. Fixed appliances, on the other hand, are known to be able to manage intricate orthodontic adjustments but come with their own set of challenges, including oral hygiene challenges. The implementation of clear aligner orthodontic treatment in surgical-orthodontic cases has increased at a gradual pace, primarily attributed to apprehension surrounding surgical procedures and the maintenance of postsurgical outcomes. However, with the increasing demand from patients for less noticeable orthodontic treatment options, it is necessary to investigate the effects of these various treatment methods on long-term stability.

Specifically, since orthodontic treatment is initiated after surgery in the SFA, an increase in the vertical dimension (VD) due to occlusal interference can occur during surgery. This VD increase is resolved through subsequent postsurgical orthodontic treatment, and the relapse associated with the surgery becomes more evident during this process. Thus, it was hypothesized that differences in the biomechanics of postsurgical orthodontic treatment, whether using clear aligners or fixed appliances, could contribute to variations in the relapse patterns following surgery. Thus, the purpose of this study was to compare the stability of postsurgical outcomes in patients with mandibular prognathism who underwent treatment with clear aligners or fixed appliances following surgery with the SFA.

MATERIALS AND METHODS

This retrospective study included patients with Class III malocclusion who underwent isolated mandibular setback surgery with postoperative orthodontic treatment using clear aligners or conventional fixed appliances at the Chonnam National University Dental Hospital in Gwangju, Korea between January 2018 and December 2022 (Figure 1). Due to the retrospective nature of this study, it was granted an exemption from ethical approval in writing by the Chonnam National University Dental Hospital Institutional Review Board (CNUDH-2022-002). This study followed the Declaration of Helsinki in terms of medical protocol and ethics and was approved by the IRB of Chonnam National University Dental Hospital. The intervention group consisted of patients treated with clear aligners. The matched-control group comprised patients treated with conventional fixed appliances and they were selected such that their age, sex, medical status, and surgical treatment plan corresponded to those of the intervention group. The matching was done using patients who were treated by the same surgeon and the same orthodontist, and efforts were made to match patients who underwent surgery and orthodontic treatment within a similar time frame. This study is reported following the Standards for Reporting of Observational Studies (STROBE) guidelines for cross-sectional studies.[6]

Twenty-seven patients with skeletal Class III malocclusion who underwent surgical orthodontic treatment with isolated mandibular setback surgery and clear aligners for their postsurgical treatment were included in the clear aligner treatment (CA) group (mean age: 23.3 $\pm$ 2.5 years; range: 19.9–28.0 years). The fixed appliance treatment (FA) group consisted of a matched sample of 27 patients who were treated with isolated mandibular setback surgery and fixed appliances for their postsurgical treatment (mean age: 22.1 $\pm$ 3.0 years; range: 18.7–29.1 years). Each patient met the following inclusion criteria: (1) skeletal Class III malocclusion, (2) underwent isolated mandibular setback surgery

Table 1. Demographic Data of the Patients[a]

	Clear Aligner Group	Fixed Appliance Group	*P*
	Mean ± SD	Mean ± SD	Value
Sex (male/female, number)	15/12	14/13	.317
Age (y)	23.3 ± 2.5	22.1 ± 3.0	.745
Treatment duration (mo)	12.0 ± 4.4	15.1 ± 3.2	.044
Amount of mandibular setback (mm)			
Right (mm)	10.2 ± 4.5	7.9 ± 6.4	.770
Left (mm)	7.7 ± 3.2	8.7 ± 3.6	.059
Difference in setback (mm)	4.1 ± 3.1	2.3 ± 1.1	.079
Amount of vertical dimension increase (mm)	1.9 ± 0.8	1.6 ± 1.1	.338
ANB (°)	−3.5 ± 2.6	−3.7 ± 3.1	.883
Mandibular plane angle (°)	35.0 ± 5.4	37.2 ± 7.2	.431
Amount of crowding (mm)			
Maxillary arch	2.2 ± 1.6	2.6 ± 2.1	.293
Mandibular arch	2.1 ± 1.2	1.8 ± 2.1	.256
Curve of Spee	2.5 ± 1.0	2.2 ± 0.6	.321

[a] SD indicates standard deviation; Independent *t* test was used for statistical significance.

with sagittal split ramus osteotomy (SSRO) and semirigid fixation, (3) crowding in the mandibular arch ≤3 mm, (4) nonextraction of maxillary premolars, and (5) cone-beam computed tomography (CBCT) scans obtained before surgery (T0), immediately after surgery (T1), 3 months after surgery (T2), 6 months after surgery (T3), and 1 year after surgery (T4). Patients with cleft lip/palate or other craniofacial syndromes, facial trauma, degenerative temporomandibular joint disease, masticatory muscle disorder, or severe facial asymmetry (≥4 mm of chin point deviation from the facial midline) and those who had undergone genioplasty were excluded.

The total treatment period was 12.0 ± 4.4 months in the CA group and 15.1 ± 3.2 months in the FA group. Patient demographic data are shown in Table 1. The surgical details were the same for the CA and FA groups. The four-hole/four-holed, L-shaped titanium plates (Stryker Leibinger GmbH & Co. KG, Freiburg, Germany) were used for semirigid fixation. Intermaxillary fixation (IMF) was released and occlusion was checked before closure. The surgical wafer was placed and four IMF screws were inserted between the canines and first premolars. Tight intermaxillary elastics were placed to stabilize the proximal segments for 3 weeks.

Patients in the CA group were treated with clear aligners made by Invisalign (Align Technology, Santa Clara, CA). Prior to orthognathic surgery, maxillary and mandibular intraoral scans were obtained from patients. Then, bite scans were obtained by capturing the surgical occlusion from the plaster dental model, and they were aligned. With postsurgical orthodontic treatment planning, the suitability of the aligners was determined via ClinCheck software (Align Technology, Santa Clara, CA, USA) (Figure 2). Postsurgical orthodontic treatment began 3 weeks after surgery, with each aligner worn for 1 week. After completing the first round of aligners, a refinement phase with additional aligners was provided.

Patients in the FA group were treated with metal braces (Empower2 metal brackets, American Orthodontics, Sheboygan, WI, USA). All patients were treated with 0.018-inch straight wire appliances with the Roth prescription and sliding mechanics, and 0.016 ×

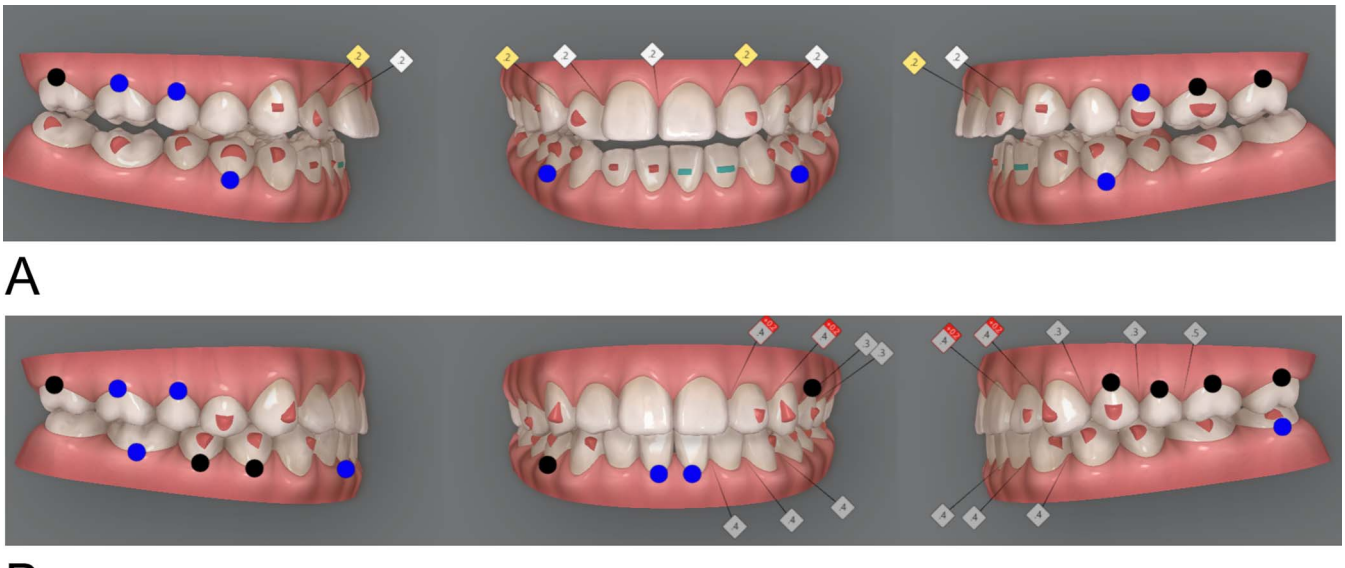

Figure 2. Simulation of postsurgical orthodontic treatment in the clear aligner treatment group. Aligners were fabricated prior to orthognathic surgery. (A) Expected occlusion immediately after surgery; (B) expected occlusion after postsurgical orthodontic treatment.

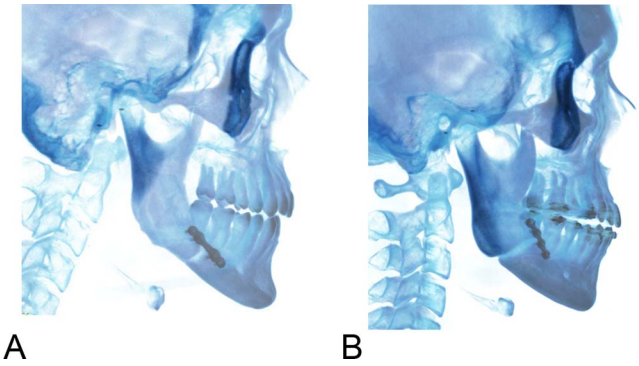

Figure 3. Lateral cephalograms generated from cone-beam computed tomography to measure postsurgical skeletal relapse in each treatment group. (A) Clear aligner treatment group; (B) Fixed appliance treatment group.

0.022-inch stainless steel wires were used for the final arch wires. During postsurgical orthodontic treatment, neither precision lingual/transpalatal arches nor mini-implants were used. Postsurgical orthodontic treatment started with the mandibular arch at 5 weeks postsurgery and then proceeded in sequence to the maxillary arch. In the FA group, Class III elastics were used during the finishing phase for less than 3 months, whereas no elastics were used in the CA group.

CBCT images were obtained using the Alphard Vega system (Asahi Roentgen, Kyoto, Japan) with the following settings: 80 kV, 5 mA, voxel size of 0.39 × 0.39 × 0.39 mm, and field of view of 200 × 179 mm. To standardize the volumetric images, the head posture of all patients was normalized using reference ear rods containing a 1.0-mm diameter titanium marker at the center.[7] Superimposition of CBCT images acquired at different time points was performed using volume-based automatic superimposition software (InVivo5, version 5.4, Anatomage, Santa Clara, CA) to obtain the degree of best fit with the cranial base. Subsequently, using the import orientation function of the software, the CBCT data after surgery were oriented in the same position as those before surgery. Lateral cephalograms were generated from the CBCT scans and precisely placed in the same coordinate system before and after surgery (Figure 3). The x-y coordinate system was used to analyze the horizontal and vertical relapse after surgery. The origin coordinates (0, 0) were set at the coordinates of nasion. The x- and y-coordinate values of B point (B), pogonion (Pog), and menton (Me) were measured at each time point (T0, T1, T2, T3, and T4) (Figure 4). Postsurgical skeletal relapse was defined as the difference in the coordinates between T1 and T2, T2 and T3, T3 and T4 in each direction. The values of forward and upward movements were described as positive, whereas those

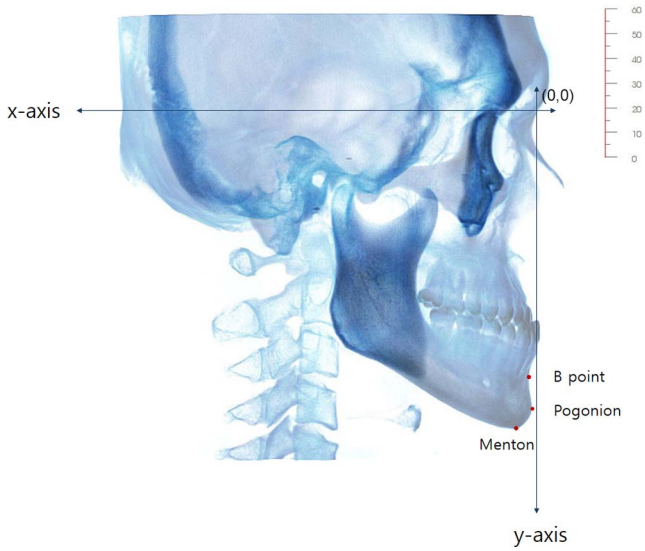

Figure 4. Nasion point oriented as (0, 0) for measurements of B point, pogonion, and menton.

in opposing directions were described as negative. Mandibular relapse was described by comparing the mandibular position at each time point (T2, T3, and T4) with the immediately preceding stage (T1, T2, and T3, respectively). This approach was taken to evaluate the amount of relapse at each stage and to assess how the extent of relapse decreased over time, with the aim of applying these findings to postsurgical orthodontic treatment planning.

A statistical power of 80% and an alpha error of 5% were used to determine the appropriate sample size. The sample size calculation for a repeated measures analysis of variance (RMANOVA) was performed according to the study by Kee et al.[8] To evaluate the effect of an intervention (CA vs FA) on postoperative mandibular movement before and after treatment, an expected effect of medium size 0.3, a statistical power of 80%, a type I error of 5%, number of groups = 2, and number of measurements = 6 were assumed by the G*power program (version 3.1.9.2, Heinrich-Heine-University, Dusseldorf, Germany). The calculation indicated 27 patients were to be included in each group. The Shapiro-Wilk test was used to assess the distribution of the data for the two groups. For normally distributed variables, Mauchly's sphericity test was used to test the equality of variances of the differences between the levels of the repeated-measures factor. A RMANOVA with the general linear model in each group was used to determine skeletal relapse in the mandible at T2, T3, and T4, and multiple comparisons were performed using the Bonferroni test. The data collected from the CA and FA groups were subjected to an analysis of covariance (ANCOVA) to determine the differences in the mean parameters of the two groups.

Table 2. Postoperative Mandibular Relapse in the Clear Aligner Treatment Group[a]

	Skeletal Relapse at T2 (T2–T1)	Skeletal Relapse at T3 (T3–T2)	Skeletal Relapse at T4 (T4–T3)	
	Mean ± SD	Mean ± SD	Mean ± SD	*P* Value
Horizontal change (mm)				
ΔB_x	1.3 ± 1.0	0.8 ± 0.8	0.6 ± 2.2	.408
ΔPog_x	1.4 ± 0.9	0.9 ± 0.9	0.9 ± 2.5	.522
ΔMe_x	1.4 ± 1.7	1.3 ± 1.6	1.0 ± 1.2	.751
Vertical change (mm)				
ΔB_y	−0.3 ± 0.8	−0.6 ± 0.8	−0.3 ± 0.6	.602
ΔPog_y	0.1 ± 1.1	−0.8 ± 1.3	−0.2 ± 0.8	.154
ΔMe_y	0.0 ± 0.2	−0.9 ± 1.4	−0.2 ± 0.8	.084

[a] SD indicates standard deviation; T1, immediately after surgery; T2, 3 months after surgery; T3, 6 months after surgery; T4, 1 year after surgery. In the horizontal movement, (+) indicates forward movement and (−) indicates backward movement. In the vertical movement, (+) indicates downward movement and (−) indicates upward movement. Repeated-measures analysis of variance was conducted to compare changes over time.

All measurements were repeated 2 weeks later by the same investigator, and the systematic intra-examiner error between the two measurements was determined using a paired *t* test. The paired *t*-test verified that no statistically significant difference was observed between the first and second measurements ($P = .189$). Therefore, it was concluded that the measurements were consistent and free from systematic error, ensuring the reliability of the data. Intraclass correlation coefficients (ICCs) were used to assess the reproducibility of the measurements. The ICC values were 0.91–0.95 for all measurements, which showed good reproducibility. All statistical analyses were performed using SPSS software (version 29.0, IBM SPSS, Armonk, NY, USA).

RESULTS

Table 2 shows the postsurgical mandibular relapse in the CA group. B point moved forward by an average of 1.3 mm at T2 compared to T1, followed by an additional 0.8 mm at T3 and another 0.6 mm at T4. Pogonion moved forward by an average of 1.4 mm at T2 compared to T1, with a further 0.9 mm at T3 and an additional 0.9 mm at T4. Although the amount of relapse gradually decreased over time, it continued to occur throughout the postoperative period. Mandibular vertical relapse was greatest at T3. The vertical movement, measuring less than 1.0 mm, showed a distinct pattern, unlike the horizontal movement. The upward movement of the mandibular position at T3 was greater than that at T2 in the CA group (Table 2). There was no statistically significant difference in the amount of horizontal and vertical movement between the initial 3 months after surgery and the subsequent 6 months and 1 year after surgery.

Table 3 shows the postsurgical mandibular relapse in the FA group. Pogonion advanced by 1.7 mm at T2, 0.3 mm at T3, and 0.3 mm at T4, with a statistically significant decrease over time. Horizontal movement was significant at B point and pogonion at T2 but reduced thereafter. Vertical relapse was minimal (< 0.7 mm), with only pogonion showing statistical significance. Vertical movement was negligible at T3 and T4, unlike in the CA group.

Comparing postsurgical relapse patterns using RMANOVA (Table 4) revealed no significant group-time interaction, but differences were evident (Figures 4 and 5). The FA group showed early relapse, whereas the CA group exhibited delayed relapse. Horizontal movement in

Table 3. Postoperative Mandibular Relapse in the Fixed Appliance Treatment Group[a]

	Skeletal Relapse at T2 (T2–T1)	Skeletal Relapse at T3 (T3–T2)	Skeletal Relapse at T4 (T4–T3)	
	Mean ± SD	Mean ± SD	Mean ± SD	*P* Value
Horizontal change (mm)				
ΔB_x	1.7 ± 1.8[a]	0.2 ± 0.9[b]	0.1 ± 0.7[b]	.005
ΔPog_x	1.7 ± 2.1[a]	0.3 ± 0.9[b]	0.3 ± 0.6[b]	.026
ΔMe_x	1.6 ± 2.0[a]	0.4 ± 0.6[b]	0.0 ± 0.4[c]	.019
Vertical change (mm)				
ΔB_y	−0.6 ± 1.3	0.0 ± 0.0	0.0 ± 0.0	.070
ΔPog_y	−0.6 ± 1.1[a]	−0.3 ± 0.7[a]	0.0 ± 0.0[b]	.046
ΔMe_y	−0.5 ± 1.3	−0.3 ± 0.5	−0.1 ± 0.6	.485

[a] SD indicates standard deviation; T1, immediately after surgery; T2, 3 months after surgery; T3, 6 months after surgery; T4, 1 year after surgery. In the horizontal movement, (+) indicates forward movement and (−) indicates backward movement. In the vertical movement, (+) indicates downward movement and (−) indicates upward movement. Repeated measures ANOVA was conducted to compare changes over time. Different superscript characters indicate the statistical significance.

Table 4. Comparison of Postoperative Mandibular Relapse Over Time Between the Clear Aligner and Fixed Appliance Treatment Groups[a]

	Clear Aligner Treatment Group			Fixed Appliance Treatment Group			
	Skeletal Relapse at T2 (T2–T1)	Skeletal Relapse at T3 (T3–T2)	Skeletal Relapse at T4 (T4–T3)	Skeletal Relapse at T2 (T2–T1)	Skeletal Relapse at T3 (T3–T2)	Skeletal Relapse at T4 (T4–T3)	*P* Value (Time * Group)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Horizontal change (mm)							
Δ B_x	1.3 ± 1.0	0.8 ± 0.8	0.6 ± 2.2	1.7 ± 1.8	0.2 ± 0.9	0.1 ± 0.7	.308
Δ Pog_x	1.4 ± 0.9	0.9 ± 0.9	0.9 ± 2.5	1.7 ± 2.1	0.3 ± 0.9	0.3 ± 0.6	.362
Δ Me_x	1.4 ± 1.7	1.3 ± 1.6	1.0 ± 1.2	1.6 ± 2.0	0.4 ± 0.6	0.0 ± 0.4	.221
Vertical change (mm)							
Δ B_y	−0.3 ± 0.8	−0.6 ± 0.8	−0.3 ± 0.6	−0.6 ± 1.3	0.0 ± 0.0	0.0 ± 0.0	.087
Δ Pog_y	0.1 ± 1.1	−0.8 ± 1.3	−0.2 ± 0.8	−0.6 ± 1.1	−0.3 ± 0.7	0.0 ± 0.0	.072
Δ Me_y	0.0 ± 0.2	−0.9 ± 1.4	−0.2 ± 0.8	−0.5 ± 1.3	−0.3 ± 0.5	−0.1 ± 0.6	.100

[a] SD indicates standard deviation; T1, immediately after surgery; T2, 3 months after surgery; T3, 6 months after surgery; T4, 1 year after surgery. In the horizontal movement, (+) indicates forward movement and (−) indicates backward movement. In the vertical movement, (+) indicates downward movement and (−) upward movement. Repeated-measures analysis of variance was conducted to compare changes over time between the two groups.

the FA group was greater at T2 but more pronounced in the CA group at T3 and T4. Vertical relapse followed a similar trend, with the CA group showing greater movement at T3.

Total relapse comparison (Table 5) showed no significant differences between groups immediately and 1-year postsurgery. Although ANCOVA results were not statistically significant, the CA group exhibited a greater total relapse. Both groups showed forward horizontal and upward vertical movement.

DISCUSSION

With the expanding clear aligner market,[9] interest in the use of clear aligners for clinical orthodontics is growing among clinicians and patients. Advancing technology[10–12] has led to more patients opting for clear aligners in SFA treatment. Thus, understanding postsurgical relapse and the impact of clear aligners on these changes is increasingly important.

In this study, horizontal mandibular relapse peaked at T2 in both groups. In the FA group, it significantly decreased at T3 and T4 whereas, in the CA group, the decrease was not statistically significant, indicating ongoing relapse. Although total relapse did not differ between groups, their postsurgical patterns varied (Figures 5 and 6). In the FA group, most horizontal relapse occurred early at T2 (3 months postsurgery) while, in the CA group, more relapse occurred later at T3 and T4 (6 months and 1 year). This "delayed relapse" is crucial in postsurgical orthodontic treatment with clear aligners. Since skeletal relapse usually decreases over time,[13] clinicians may focus less on it after 6 months. However, if significant relapse occurs unexpectedly beyond this point, it may be harder to manage. Vertical mandibular relapse was minimal at T3 and T4 in the FA group but peaked at T3 in the CA group. Due to SFA treatment, VD increases more during surgery than in COS treatment, but tends to decrease postoperatively as the surgical wafer is removed. In the FA group, full bonding and alignment after surgical wafer removal facilitated VD reduction, leading to mandibular hinge movement. In contrast, in the CA group, continuous aligner wear slowed VD reduction compared to the FA group. The aligner used was 0.75 mm thick, whereas the surgical wafer was 1.0 mm. Though the difference is minimal, the slower VD decrease in the CA group may have been due to continuous aligner use.

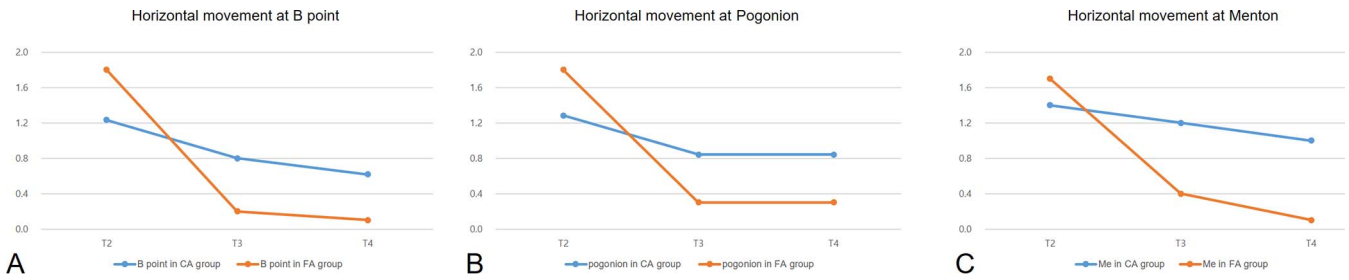

Figure 5. Horizontal postsurgical mandibular movement over time measured at B point (A), pogonion (B), and menton (C). T2, 3 months after surgery; T3, 6 months after surgery; T4, 1 year after surgery.

Table 5. Comparison of Total Relapse in Postoperative Mandibular Position Between the Clear Aligner and Fixed Appliance Treatment Groups[a]

	Clear Aligner Treatment Group	Fixed Appliance Treatment Group	
	Total Skeletal Relapse (T4–T1)	Total Skeletal Relapse (T4–T1)	
	Mean ± SD	Mean ± SD	*P* Value
Horizontal change (mm)			
Δ B_x	2.8 ± 3.2	2.0 ± 1.9	.353
Δ Pog_x	3.2 ± 3.7	2.2 ± 2.3	.295
Δ Me_x	3.8 ± 3.4	1.9 ± 2.4	.118
Vertical change (mm)			
Δ B_y	−1.3 ± 1.4	−0.6 ± 1.3	.344
Δ Pog_y	−0.9 ± 2.1	−0.9 ± 1.0	.895
Δ Me_y	−1.2 ± 2.4	−1.0 ± 1.5	.841

[a] SD indicates standard deviation; T1, immediately after surgery; T4, 1 year after surgery. In the horizontal movement, (+) indicates forward movement and (−) indicates backward movement. In the vertical movement, (+) indicates downward movement and (−) indicates upward movement. ANCOVA was done for comparison between the two groups.

The causes of skeletal changes observed after surgery are highly diverse. The horizontal and vertical changes in B point and Pogonion may be influenced by various factors, including differences in postoperative dental movement patterns resulting from biomechanical differences between fixed appliances and clear aligners. However, the most distinct difference between the two treatment groups was that patients in the CA group continued to wear their aligners postoperatively, whereas those in the FA group did not. This consistent aligner wear may have created an intraoral environment similar to that of prolonged surgical wafer use, potentially contributing to the continued postsurgical changes observed in the clear aligner group. In contrast, the FA group, which began active tooth movement immediately after surgical wafer removal, exhibited more substantial mandibular changes in the early phase, with minimal changes thereafter. These findings suggest that the continued wear of aligners may be a key factor influencing the prolonged skeletal changes seen in the CA group.

The clear aligner group had a significantly shorter treatment duration (12 vs 15.1 months for the FA group). This difference likely stemmed from the earlier start of postsurgical orthodontic treatment. Presurgical intraoral scanning enabled aligner fabrication in advance, allowing immediate wear after wafer removal. This optimized the rapid acceleratory phenomenon, promoting faster tooth movement and reducing overall treatment time.

Kee et al.[8] examined alveolar bone changes in skeletal Class III patients treated with SFA and COS, finding reductions in vertical bony levels, horizontal bone thickness, and alveolar bone area around mandibular incisors in both groups. Although differences were not significant, bone loss was greater in the COS group, indicating a periodontal advantage of SFA. Thus, assessing alveolar bone changes in postsurgical orthodontic treatment with fixed appliances or clear aligners is essential for evaluating treatment outcomes.

3D printing in dentistry is a developing technology, significantly impacting the clear aligner market. This advancement has led to the introduction of direct-printed aligners, which offer a new approach to orthodontic treatment.[14,15] The advantage of a direct-printed aligner system is the capability to customize the aligner thickness for each individual tooth, in contrast to controlling tooth movement by using different shapes of attachments.[16] In SFA treatment, the use of direct-printed aligners designed to minimize thickness in the posterior tooth area for postsurgical orthodontic treatment might rapidly

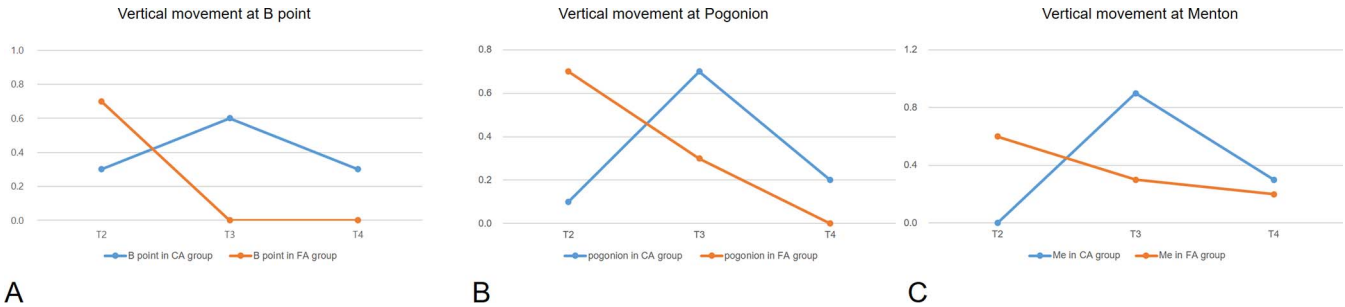

Figure 6. Vertical postsurgical mandibular movement over time measured at B point (A), pogonion (B), and menton (C). T2, 3 months after surgery; T3, 6 months after surgery; T4, 1 year after surgery.

resolve the VD increase that occurs after surgery, potentially reducing the risk of delayed relapse. In addition, all patients included in this study underwent orthognathic surgery using SSRO. Although outcomes for IVRO (intraoral vertical ramus osteotomy) cases cannot be determined from this study, the overall postoperative skeletal relapse patterns would not be expected to significantly differ clinically. However, further studies are needed to confirm this in the future.

Although there were no statistically significant differences in surgical relapse between the CA and FA groups, the use of aligners versus traditional brackets resulted in different patterns of mandibular relapse. When starting postsurgical orthodontic treatment for SFA patients, in the case of clear aligner treatment, positional changes of the mandible may continue to occur up to 1 year after surgery, and clinicians should take this into consideration during postsurgical orthodontic treatment.

CONCLUSIONS

- The CA group showed a greater tendency to relapse than the FA group, with relapse occurring later in the CA group compared to the FA group, though differences were not statistically significant.
- Thus, careful consideration is needed in the postsurgical management of patients treated with clear aligners in the SFA.

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