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Original Article

The influence of initial incisal overlap on mandibular plane rotation, 3D airway dimensions, and hyoid bone changes following surgery-first mandibular setback in skeletal Class III patients: A pilot study

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Angle Class III;
Mandible;
Orthognathic surgery;
Upper airway

Abstract *Background/purpose:* Skeletal Class III malocclusion often requires mandibular setback, which can affect airway patency and skeletal stability, particularly when managed with a surgery-first orthognathic approach (SFOA). This study evaluated the influence of initial incisal overlap on mandibular plane (MP) rotation, pharyngeal airway volume, and hyoid bone position following surgery-first isolated mandibular setback in skeletal Class III patients.
Materials and methods: Nineteen patients (mean age, 24.5 ± 4.22 years) treated with a SFOA were grouped by initial overbite (OB): Group 1 (OB ≥ 0 mm; n $= 11$) and Group 2 (OB < 0 mm; n $= 8$). Cone-beam computed tomography and cephalograms were analyzed at pretreatment, 1 month, and 1 year postoperatively. Changes in airway volumes, minimum cross-sectional area (MCSA), hyoid position, and MP angle were assessed. Statistical comparisons and correlation analyses were performed ($P < 0.05$).
Results: Group 1 showed significantly greater total horizontal mandibular setback and more pronounced clockwise (CW) MP rotation. Both groups demonstrated postero-inferior hyoid bone displacement; Group 1 exhibited greater vertical displacement, whereas Group 2 showed significantly greater upward hyoid bone movement. Total airway volume decreased significantly in both groups, primarily due to oropharyngeal volume reduction. No significant correlations were found between skeletal changes and airway volume.
Conclusion: Initial incisal overlap appeared to influence postoperative MP rotation, skeletal

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stability, hyoid bone adaptation, and airway changes in SFOA-treated skeletal Class III patients. This suggested that controlling MP rotation and maintaining anterior occlusal support may minimize skeletal relapse and postoperative airway compromise.
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Introduction

Skeletal Class III malocclusion, a condition characterized by mandibular prognathism, affects 2%–17% of the global population, with a notable prevalence of 15.8% in Southeast Asia.[1,2] The correction of this deformity often necessitates surgical intervention, such as mandibular setback or bimaxillary orthognathic surgery. Prior investigations have demonstrated that mandibular setback, particularly through the conventional orthognathic approach (COA), can lead to a reduction in upper airway dimensions and a postero-inferior hyoid bone displacement.[3,4] Given the intricate anatomical network connecting the hyoid bone to the pharynx, mandible, and cranium, these positional alterations may compromise pharyngeal airway patency and, consequently, elevate the risk of obstructive sleep apnea (OSA).[5,6]

The surgery-first orthognathic approach (SFOA) has gained considerable traction in clinical practice due to its potential to reduce overall treatment duration by eliminating the need for presurgical orthodontic preparation. However, some studies have reported a higher incidence of postoperative skeletal relapse with SFOA compared to COA, particularly in the pogonion and supramentale (point B).[7,8] The stability of the surgical outcome is influenced by a range of skeletal and dental factors. Ko et al.[9] identified a correlation between skeletal relapse following SFOA and variables such as the extent of setback, overbite (OB), overjet (OJ), and the curve of Spee. Furthermore, intraoperative clockwise (CW) rotation of the mandibular proximal segment has been recognized as a contributing factor to skeletal instability.[10]

While cone-beam computed tomography (CBCT) offers a high-resolution, low-radiation modality for assessing

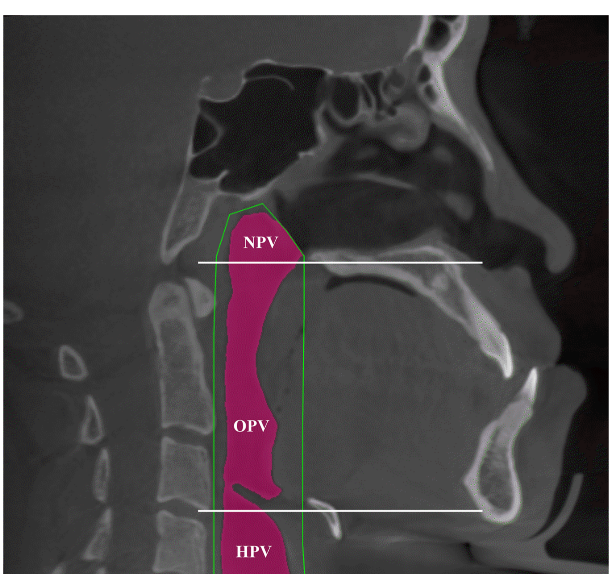

Figure 1 Segmentation of nasopharynx volume (NPV), oropharynx volume (OPV), and hypopharynx volume (HPV).

Table 1 Definitions of pharyngeal airway space boundaries used in the study.

Area	Anatomical boundaries
Nasopharynx (NP)	
Anterior	Frontal plane ⊥ to Frankfort horizontal (FH) plane, passing through posterior nasal spine (PNS)
Posterior	Posterior soft tissue contour of the pharyngeal wall
Superior	Superior soft tissue contour of the pharyngeal wall
Inferior	Horizontal plane//to FH plane passing through PNS and extending to the posterior pharyngeal wall
Lateral	Lateral soft tissue contour of the pharyngeal wall
Oropharynx (OP)	
Anterior	Same vertical plane as the nasopharynx
Posterior	Posterior soft tissue contour of the pharyngeal wall
Superior	Horizontal plane//to FH plane passing through PNS and extending to the posterior pharyngeal wall
Inferior	Horizontal plane//to FH plane passing through the anterior-inferior point of C3 vertebra (C3ai)
Lateral	Lateral soft tissue contour of the pharyngeal wall
Hypopharynx (HP)	
Anterior	Same vertical plane as the nasopharynx
Posterior	Posterior soft tissue contour of the pharyngeal wall
Superior	Horizontal plane//to FH plane passing through the anterior-inferior point of C3 vertebra (C3ai)
Inferior	Horizontal plane//to FH plane passing through the anterior-inferior point of C4 vertebra (C4ai)
Lateral	Lateral soft tissue contour of the pharyngeal wall

Modified based on: Tseng YC et al.,[12] Hsu WE et al.[13] and Canellas JV et al.[14]

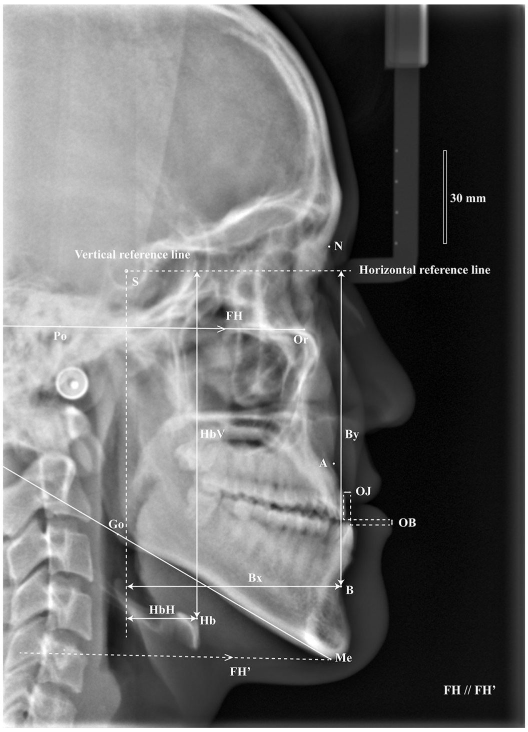

Figure 2 Cephalometric landmarks and measurements: S, sella; N, nasion; A, subspinale (point A); B, supramentale (point B); Po, porion; Or, orbitale; Go, gonion; Me, menton; Hb, hyoid bone; FH, Frankfort horizontal plane; FH', constructed plane parallel to FH; OB, vertical distance between incisal edges of upper and lower incisors; OJ, horizontal distance between incisal edges of upper and lower incisors; Bx, horizontal distance from point B to vertical reference line; By, vertical distance from point B to horizontal reference line; HbH, horizontal distance from Hb to vertical reference line; HbV, vertical distance from Hb to horizontal reference line.

pharyngeal airway and craniofacial structures,[5,11] limited studies have specifically investigated the postoperative changes in pharyngeal airway volume and hyoid bone position in patients who have undergone isolated mandibular setback via SFOA.

Considering the intimate anatomical relationship among the mandible, pharynx, and hyoid bone, this study was designed to evaluate the postoperative changes in pharyngeal airway volume and hyoid bone position in skeletal Class III patients treated with isolated mandibular setback surgery using SFOA, with data acquired from CBCT. A secondary objective was to ascertain the correlation between these postoperative changes and the patient's initial incisal overlap and mandibular plane (MP) rotation.

Materials and methods

This prospective study was approved by the Human Research Ethics Committee of the Faculty of Dentistry, Chulalongkorn University (HREC-DCU 2023-066). Nineteen adult patients (9 men, 10 women; mean age, 24.5 $\pm$ 4.22 years) diagnosed with skeletal Class III malocclusion (ANB $<$ 0.5°) underwent isolated mandibular setback via bilateral sagittal split ramus osteotomy (BSSRO) with the modified Epker technique. The amount of mandibular setback was determined by presurgical virtual surgical planning and model surgery to achieve the transitional occlusion and facial profile. Rigid fixation was performed using a single four-hole miniplate (two proximal and two distal) secured with screws on each side. All procedures were performed within a SFOA using standard procedures from August 2023 to March 2025.

Inclusion and exclusion criteria were as follows:

Inclusion criteria
(1) Systemically healthy individuals
(2) Age greater than 18 years

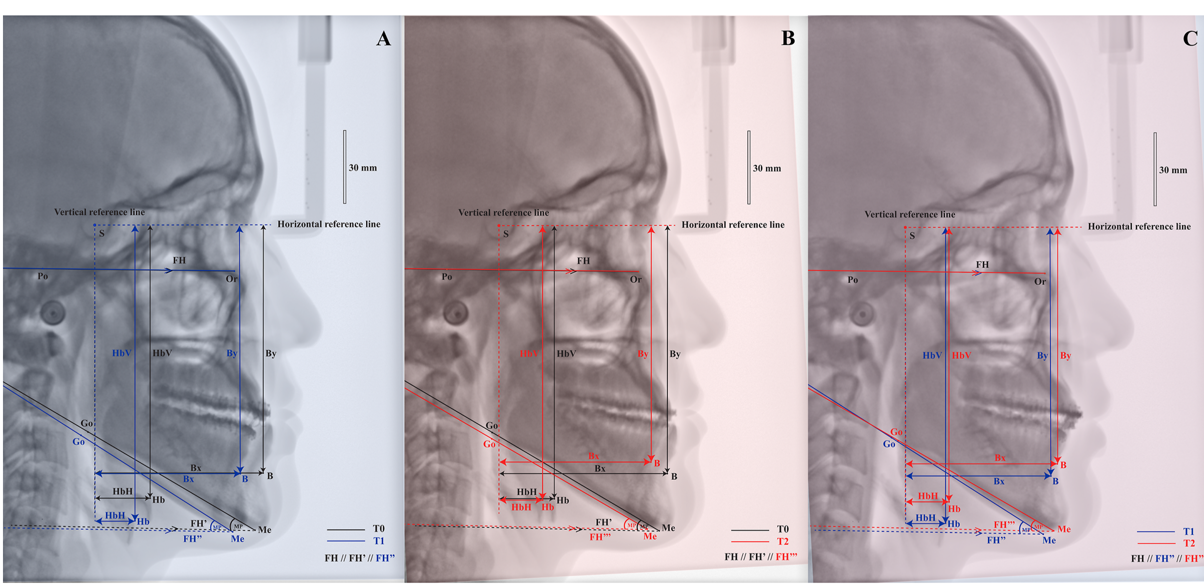

Figure 3 Cephalometric superimposition at the cranial base showing changes in the mandibular position (Bx, By), hyoid bone position (HbH, HbV), and mandibular plane angle (MP) after surgery. (A) The changes after 1 month (T1—T0). (B) The changes after 1 year (T2—T0). (C) Showing the relapse of surgery (T2—T1). T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative.

(3) Availability of high-quality CBCT and lateral cephalograms at three distinct time points: pretreatment (T0), 1 month postoperative (T1), and 1 year postoperative (T2)
(4) Absence of craniofacial syndromes or systemic conditions affecting growth or the airway

Exclusion criteria
(1) OSA patients or the presence of OSA symptoms
(2) Body mass index (BMI) greater than 30 kg/m^2
(3) Missing or loss of permanent incisors
(4) Severe facial asymmetry
(5) A history of previous orthognathic surgery or trauma

Patients were stratified into two groups based on initial OB measurement at T0:

Group 1 (positive OB): OB $\geq$ 0 mm; n = 11
Group 2 (negative OB): OB $<$ 0 mm; n = 8

CBCT scans were acquired by a radiologist using the 3D Accuitomo (J Morita, Kyoto, Japan) with patients

Table 2 Descriptive statistics for baseline demographics and skeletal measurements between groups.

Variable	Group 1	Group 2	*P* value
OB (mm)	1.69 ± 1.20	−1.34 ± 0.58	<0.001**
OJ (mm)	−2.87 ± 2.81	−1.49 ± 1.26	0.213
SNA (°)	82.67 ± 3.64	83.77 ± 3.23	0.504
SNB (°)	85.7 ± 2.94	84.88 ± 2.87	0.554
ANB (°)	−3.03 ± 1.83	−1.11 ± 1.24	0.020^{a}
MP (°)	24.99 ± 3.76	28.74 ± 4.75	0.071
SetbackX T1-T0 (mm)	−9.52 ± 3.17	−7.33 ± 2.05	0.085
SetbackX T2-T0 (mm)	−6.44 ± 2.57	−3.43 ± 3.56	0.046^{a}
RelapseX T2-T1 (mm)	3.09 ± 1.28	3.91 ± 4.53	0.574
SetbackY T1-T0 (mm)	2.56 ± 2.10	1.30 ± 1.35	0.158
SetbackY T2-T0 (mm)	0.88 ± 1.83	−0.22 ± 1.19	0.157
RelapseY T2-T1 (mm)	−1.68 ± 1.94	−1.53 ± 0.97	0.839

Data are presented as the mean ± standard deviation.
Group 1: positive overbite; Group 2: negative overbite.
Abbreviations: OB, overbite; OJ, overjet; SNA, Sella-Nasion-A point angle; SNB, Sella-Nasion-B point angle; ANB, A point-Nasion-B point angle; MP, mandibular plane angle is formed by Frankfort horizontal plane (FH) and Go-Me plane; SetbackX, horizontal mandibular setback; SetbackY, vertical mandibular setback; RelapseX, horizontal mandibular relapse; RelapseY, vertical mandibular relapse; T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative; T1-T0, the change after 1 month surgery; T2-T0, the change after 1 year surgery; T2-T1, showing the relapse.
SetbackX: + indicates anterior movement, − indicates posterior movement.
SetbackY: + indicates downward movement, − indicates upward movement.
^{a} $P < 0.05$; **$P < 0.001$.

Table 3 Repeated-measures ANOVA for hyoid position and MP angle across time points.

Variables	Group 1							Group 2						
	T0	T1	T2	*P* value (ANOVA)	*P* value (T0 vs T1)	*P* value (T0 vs T2)	*P* value (T1 vs T2)	T0	T1	T2	*P* value (ANOVA)	*P* value (T0 vs T1)	*P* value (T0 vs T2)	*P* value (T1 vs T2)
MP (°)	24.99 ± 3.76^{a}	28.08 ± 3.90^{b}	26.69 ± 3.82^{c}	<0.001	<0.001	0.011	0.005	28.74 ± 4.75^{a}	30.91 ± 4.24^{b}	28.87 ± 4.18^{a}	<0.001	0.002	0.683	<0.001
HbH (mm)	14.29 ± 5.98^{a}	10.97 ± 6.64^{b}	11.70 ± 5.94^{b}	<0.001	0.002	0.007	0.304	21.30 ± 4.78^{a}	17.15 ± 7.48^{b}	17.79 ± 6.86^{b}	0.022	0.017	0.029	0.696
HbV (mm)	103.64 ± 9.78^{a}	108.51 ± 10.57^{b}	106.40 ± 11.27^{c}	<0.001	<0.001	0.006	0.043	101.36 ± 12.91^{a}	108.01 ± 12.64^{b}	101.69 ± 12.26^{a}	<0.001	<0.001	0.828	0.012

Group 1: positive overbite; Group 2: negative overbite.
Abbreviations: MP, mandibular plane angle is formed by Frankfort horizontal plane (FH) and Go-Me plane; HbH, horizontal hyoid bone position; HbV, vertical hyoid bone position; T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative.
The least significant difference (LSD) test was used to compare the 3 time points.
$^{a, b, c}$ Values with different superscript letters are significantly different among time points ($P < 0.05$).

positioned upright, maximum intercuspation, and the occlusal plane parallel to the floor. During scanning, patients were instructed to relax the tongue and refrain from swallowing. After each scan, tongue and hyoid bone positions were reviewed to confirm the absence of movement. Airway evaluation was performed using an extended field of view (17 × 23 cm), with imaging parameters set at 5.0 mA and 90 kVp. Digital Imaging and Communications in Medicine (DICOM) files were imported into Dolphin Imaging software (version 11.95) and segmented into nasopharyngeal (NP), oropharyngeal (OP), and hypopharyngeal (HP) regions (Fig. 1 and Table 1). The total airway volume (TAV, mm^3) and minimum cross-sectional area (MCSA, mm^2) were also recorded.[12–14]

Measurements of incisal overlap, mandibular setback, hyoid bone position, and MP rotation were derived from lateral cephalograms (Fig. 2). Postoperative changes (ΔT1–T0, ΔT2–T0, and ΔT2–T1) were evaluated through cephalometric superimposition (Fig. 3).[15] All measurements were conducted in duplicate by a single calibrated examiner, with a 1-month interval.

Statistical analysis

The Shapiro–Wilk test was used to assess the normality of data distribution. Intragroup changes over time were analyzed using a repeated measures ANOVA followed by Fisher's LSD test. Intergroup differences were compared using independent *t*-tests. Pearson correlation coefficients were employed to evaluate the associations among variables. Statistical significance was set at $P < 0.05$. Intra-examiner reliability was confirmed with intraclass correlation coefficients (ICC) > 0.75. All variables met a Cronbach's alpha ≥ 0.80.

Results

At T0, Group 1 presented with a significantly smaller ANB angle and a significantly greater total horizontal setback at T2 compared to Group 2 ($P < 0.05$). However, no statistically significant difference in mandibular relapse was observed between the groups (Table 2).

There was no significant intergroup difference in MP angle at T0. At T1, both groups demonstrated a significant increase in MP angle (Table 3). At T2, Group 1 exhibited a greater overall change in MP angle, signifying more pronounced CW mandibular rotation compared to Group 2 (Fig. 4, Table 4).

Both groups experienced postero-inferior hyoid bone displacement at T1. Only Group 1 showed a significant vertical change across all time points (Fig. 5). At T2, Group 1 exhibited greater inferior displacement, while Group 2 showed more posterior movement, though these differences were not statistically significant. From T1 to T2, Group 2 demonstrated significantly greater upward hyoid bone movement compared with Group 1 ($P = 0.042$) (Tables 3 and 4).

TAV significantly decreased from T0 to T1 and T2 within each group. However, a significant reduction in MCSA was observed in Group 1 (Fig. 6, Table 5). While Group 2 experienced a greater reduction in TAV at T1 and T2, this difference was not statistically significant between the groups (Table 6). OP volume significantly decreased at T1 in both groups and at T2 in Group 1, contributing to the overall reduction in TAV (Table 5).

Correlation analysis revealed a negative correlation between initial OB and mandibular setback, and a positive correlation with MP rotation. Initial OJ was positively correlated with mandibular setback. The correlation coefficients ranged from 0.40 to 0.70, indicating a low to moderate level of correlation. No significant association was found between skeletal variables and changes in airway volume (Table 7).

Discussion

To minimize operative variability, a standardized surgical protocol was implemented in this study. Due to the absence of preoperative dental decompensation in SFOA, a transitional occlusion with positive OJ was planned for patients

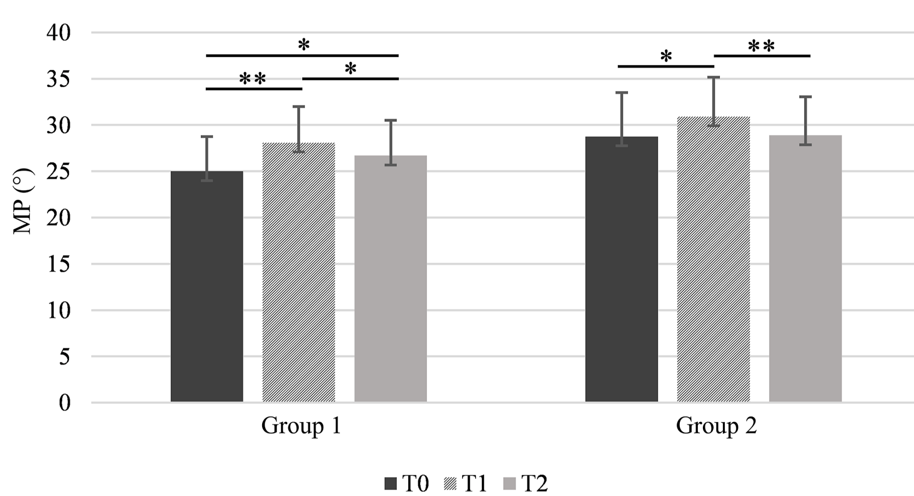

Figure 4 Changes in mean mandibular plane angle (MP) of both groups at T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative. (*$P < 0.05$; **$P < 0.001$.)

Table 4 Independent *t*-test comparing skeletal and hyoid position changes between groups at each time interval.

Variables		Group 1	Group 2	Mean difference (95%CI)	*P* value
ΔMP (°)	T1-T0	3.09 ± 1.65	2.17 ± 1.23	0.93 ± 0.69	0.199
	T2-T0	1.70 ± 1.81	0.12 ± 0.82	1.58 ± 0.69	0.036[a]
	T2-T1	−1.39 ± 1.29	−2.05 ± 0.71	0.65 ± 0.51	0.216
ΔHbH (mm)	T1-T0	−3.33 ± 2.63	−4.15 ± 3.79	0.82 ± 1.47	0.582
	T2-T0	−2.59 ± 2.56	−3.51 ± 3.62	0.92 ± 1.41	0.525
	T2-T1	0.73 ± 2.25	0.64 ± 4.45	0.09 ± 1.71	0.958
ΔHbV (mm)	T1-T0	4.86 ± 1.49	6.65 ± 3.33	−1.79 ± 1.26	0.190
	T2-T0	2.76 ± 2.62	0.33 ± 4.15	2.43 ± 1.55	0.136
	T2-T1	−2.11 ± 3.01	−6.32 ± 5.33	4.21 ± 1.92	0.042[a]

Group 1: positive overbite; Group 2: negative overbite.
Abbreviations: ΔMP, change in mandibular plane angle; ΔHbH, change in horizontal hyoid position; ΔHbV, change in vertical hyoid position; T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative; T1-T0, the change after 1 month surgery; T2-T0, the change after 1 year surgery; T2-T1, showing the relapse.
ΔHbH: + indicates anterior hyoid movement, - indicates posterior hyoid movement.
ΔHbV: + indicates downward hyoid movement, - indicates upward hyoid movement.
ΔMP: + indicates clockwise rotation, - indicates counterclockwise rotation.
[a] Statistically significant difference at $P < 0.05$.

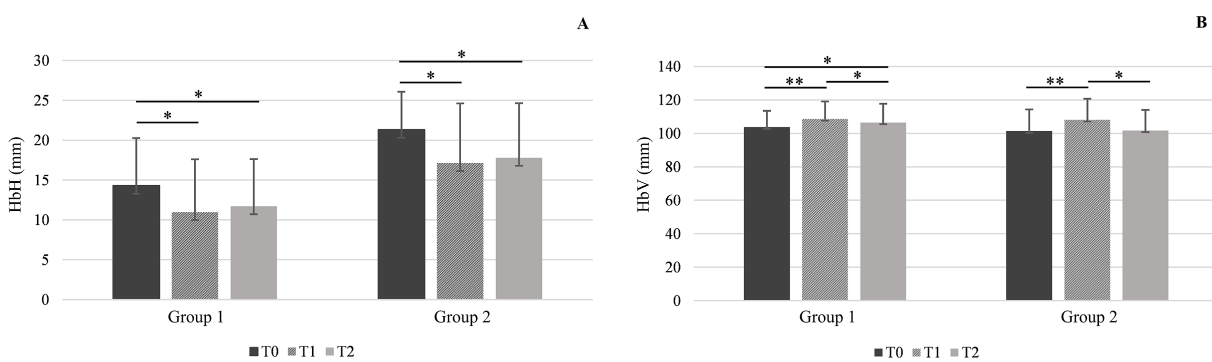

Figure 5 Changes in mean hyoid bone position of both groups at T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative. (A) Horizontal hyoid bone position (HbH). (B) Vertical hyoid bone position (HbV). (*$P < 0.05$; **$P < 0.001$.)

with anterior open bite. This occlusion setup aimed to mitigate potential postoperative relapse and influence mandibular rotation.[16] Consequently, initial incisal overlap appeared to influence both the magnitude of mandibular setback and the extent of postoperative relapse in skeletal Class III malocclusion patients undergoing SFOA. While Group 1 presented with a more severe initial deformity, Group 2 demonstrated a numerically greater horizontal relapse (though this finding was not statistically significant), resulting in a smaller final net setback.

Distinct patterns of MP rotation were observed. Group 1 displayed a significantly greater CW MP rotation than Group 2, whose angle reverted to a near-baseline value. This may be attributed to a deeper curve of Spee and extrusion of

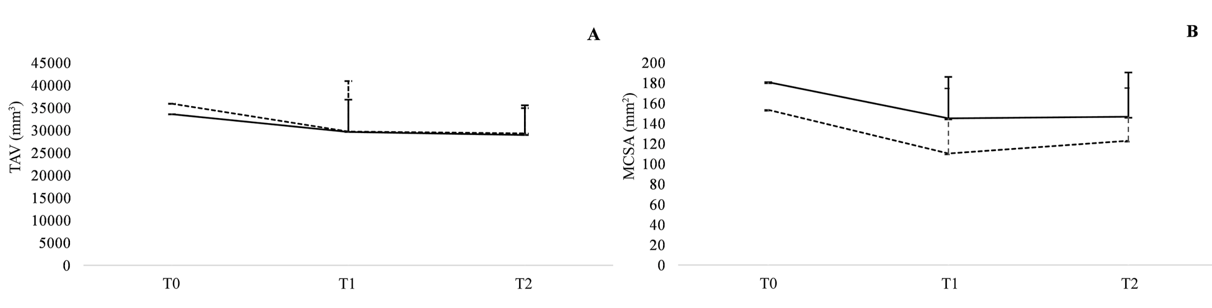

Figure 6 Changes in mean airway measurements of both groups at T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative. (A) Total airway volume (TAV). (B) Minimum cross-sectional area (MCSA).

Table 5 Repeated-measures ANOVA for airway volumes and MCSA across time points.

Variables	Group 1							Group 2						
	T0	T1	T2	*P* value (ANOVA)	*P* value (T0 vs T1)	*P* value (T0 vs T2)	*P* value (T1 vs T2)	T0	T1	T2	*P* value (ANOVA)	*P* value (T0 vs T1)	*P* value (T0 vs T2)	*P* value (T1 vs T2)
NPV (mm^3)	7655.73 ± 2276.76[a]	6654.36 ± 2540.06[b]	6635.55 ± 2142.44[b]	0.005	0.006	<0.001	0.955	7764.25 ± 1695.81[a]	7196.25 ± 1775.65[a]	6806.63 ± 1414.91[a]	0.084	0.084	0.089	0.354
OPV (mm^3)	20017.27 ± 5531.39[a]	17541.09 ± 4976.45[b]	17148.18 ± 5504.05[b]	0.042	0.046	<0.001	0.763	23389.25 ± 9778.61[a]	17936.25 ± 3977.57[b]	17526.00 ± 6019.47[ab]	0.030	0.042	0.059	0.804
HPV (mm^3)	5910.55 ± 1678.82[a]	5418.00 ± 1430.04[a]	5199.00 ± 1218.01[a]	0.235	0.199	0.179	0.573	4796.25 ± 1118.60[a]	4596.88 ± 1064.54[a]	4953.25 ± 1805.10[a]	0.811	0.678	0.765	0.604
TAV (mm^3)	33583.55 ± 7188.09[a]	29613.45 ± 6579.93[b]	28950.55 ± 7766.43[b]	0.002	0.004	<0.001	0.671	35906.75 ± 11183.72[a]	29729.38 ± 5638.05[b]	29285.88 ± 7500.33[b]	0.022	0.043	0.041	0.803
MCSA (mm^2)	180.82 ± 41.03[a]	145.00 ± 43.82[b]	146.55 ± 55.67[b]	0.037	0.014	0.038	0.928	153.50 ± 64.34[a]	110.25 ± 52.09[a]	122.88 ± 38.61[a]	0.075	0.057	0.077	0.530

Group 1: positive overbite; Group 2: negative overbite.
Abbreviations: NPV, nasopharynx volume; OPV, oropharynx volume; HPV, hypopharynx volume; TAV, total airway volume; MCSA, minimum cross-sectional area; T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative.
The least significant difference (LSD) test was used to compare the 3 time points.
[a, b, c] Values with different superscript letters are significantly different among time points ($P < 0.05$).

Table 6 Independent *t*-test comparing airway volumes and MCSA changes between groups at each time interval.

Variables		Group 1	Group 2	Mean difference (95%CI)	*P* value
NPV (mm^3)	T1-T0	−1001.36 ± 968.87	−568.00 ± 797.26	−433.36 ± 419.20	0.316
	T2-T0	−1020.18 ± 483.29	−957.63 ± 1370.79	−62.56 ± 506.08	0.905
	T2-T1	−18.82 ± 1071.67	−389.63 ± 1111.35	370.81 ± 505.63	0.473
OPV (mm^3)	T1-T0	−2476.18 ± 3606.36	−5453.00 ± 6223.84	2976.82 ± 2454.46	0.252
	T2-T0	−2869.09 ± 1934.84	−5863.25 ± 7379.63	2994.16 ± 2673.52	0.296
	T2-T1	−392.91 ± 4205.99	−410.25 ± 4509.92	17.34 ± 2013.71	0.993
HPV (mm^3)	T1-T0	−492.55 ± 1188.25	−199.38 ± 1302.34	−293.17 ± 574.55	0.616
	T2-T0	−711.55 ± 1632.49	157.00 ± 1428.36	−868.55 ± 721.01	0.245
	T2-T1	−219.00 ± 1246.25	356.38 ± 1857.41	−575.38 ± 709.91	0.429
TAV (mm^3)	T1-T0	−3970.09 ± 3552.45	−6177.38 ± 7070.76	2207.28 ± 2459.19	0.382
	T2-T0	−4633.00 ± 2782.04	−6620.88 ± 7494.79	1987.88 ± 2779.40	0.494
	T2-T1	−662.91 ± 5024.58	−443.50 ± 4844.55	−219.41 ± 2300.64	0.925
MCSA (mm^2)	T1-T0	−35.82 ± 40.10	−43.25 ± 53.76	7.43 ± 21.47	0.734
	T2-T0	−34.27 ± 47.67	−30.63 ± 41.82	−3.65 ± 21.07	0.865
	T2-T1	1.55 ± 55.23	12.63 ± 54.11	−11.08 ± 25.45	0.669

Group 1: positive overbite; Group 2: negative overbite.
Abbreviations: NPV, nasopharynx volume; OPV, oropharynx volume; HPV, hypopharynx volume; TAV, total airway volume; MCSA, minimum cross-sectional area; T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative; T1-T0, the change after 1 month surgery; T2-T0, the change after 1 year surgery; T2-T1, showing the relapse.
*Statistically significant difference at $P < 0.05$.

posterior teeth during postsurgical orthodontic treatment.[17] The counterclockwise (CCW) rebound observed in Group 2 might be influenced by the upward and forward forces exerted by the suprahyoid and lateral pterygoid muscles.[18,19]

Consistent with previous studies,[3,4,20–27] both study groups experienced postero-inferior hyoid bone displacement at T1. Over the one-year follow-up period, Group 2 demonstrated greater vertical relapse and upward movement of the hyoid bone. The absence of anterior occlusal support in patients with reduced OB may diminish neuromuscular resistance, thereby facilitating the posterior displacement of the hyoid bone and tongue. This, in turn, may compromise airway patency and contribute to the CCW MP relapse pattern.[27]

Our findings are consistent with other studies, confirming a significant postoperative reduction in TAV and MCSA,[14,28–31] primarily localized to the OP region.[32] The rebound of MP angle and upward hyoid bone movement in Group 2 may explain the minor HP volume increase at T2, suggesting that postoperative pharyngeal airway changes are influenced by MP rotation and hyoid adaptation, not solely by the magnitude of the mandibular setback.

Table 7 Pearson correlation coefficients among dental and skeletal variables.

Variable 1	Variable 2	*r*-value	*P* value
OB	ΔMP T1-T0	0.492[a]	0.032
	SetbackX T1-T0	−0.488[a]	0.034
	SetbackX T2-T0	−0.487[a]	0.035
OJ	SetbackX T1-T0	0.717[b]	0.001
	SetbackX T2-T0	0.499[a]	0.030
SetbackX T2-T1	ΔHbH T2-T1	0.489[a]	0.034

Abbreviations: OB, overbite; OJ, overjet; ΔMP, change in mandibular plane angle; ΔHbH, change in horizontal hyoid position; SetbackX, horizontal mandibular setback; T0, before surgery; T1, 1 month postoperative; T2, 1 year postoperative; T1-T0, the change after 1 month surgery; T2-T0, the change after 1 year surgery; T2-T1, showing the relapse.
[a] Correlation is significant at the 0.05 level (2-tailed).
[b] Correlation is significant at the 0.01 level (2-tailed).

Correlation analysis revealed that the OB was positively correlated with CW MP rotation, as well as the OJ and sagittal setback. Although patients with greater OB underwent larger setbacks, the inverse correlation (negative *r*-value) indicated the numeric definition of setback as a negative value. Our correlation coefficients were consistent with previous studies, indicating low to moderate strength correlations.[3,33] Similarly, this study found no significant association between skeletal variables and airway volume, consistent with the findings of Irani et al.[34] This suggests that airway volume may be influenced by multifactorial influences and surrounding soft tissue compensatory mechanisms, rather than a direct linear relationship with skeletal morphology.

In conclusion, initial incisal overlap may influence MP rotation, skeletal stability, hyoid adaptation, and airway changes in skeletal Class III patients treated with SFOA. However, the limited sample of this study may have an impact on the statistical power and the generalizability of the findings. Furthermore, a one-year follow-up remains relatively short for evaluating true skeletal stability and airway adaptation. Future studies with larger samples and longer follow-up periods are necessary to confirm these findings.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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