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Original Article

How Similar are the Dentoskeletal Characteristics of Class III Double-Jaw Surgery Patients with Ideal Post-Treatment Profiles and Class I Subjects?

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Main Points

- The maxilla and soft -tissue chin were protrusive in Class III double-jaw surgery patients with ideal final soft-tissue profiles compared with skeletally harmonious subjects.
- Soft-tissues masked one-third of the maxillary and one-fourth of the mandibular surgical correction.
- Although the mandibular incisors were slightly compensated before surgery and further retroclined at the post-surgical phase, the soft-tissue outcome was not adversely affected.

ABSTRACT

Objective: To define the dental and skeletal characteristics of Class III surgery patients with ideal final soft-tissue profiles, and to compare them with those of Class I subjects. Also, to show how soft-tissues respond to surgical jaw movements and contribute to the outcome.

Methods: This short-term, retrospective study was conducted using pre-treatment (T0), pre-surgery (T1), and post-treatment (T2) records of 50 double-jaw Class III surgery patients who presented with ideal cephalometric characteristics in sagittal (Holdaway and soft-tissue convexity angles) and vertical dimensions (GoGn. SN angle and upper-to-lower face harmony) at the end of treatment, and 50 control subjects.

Results: At T2, the horizontal distance between the vertical reference plane (a perpendicular plane to the horizontal reference plane that is angulated 7° clockwise to the SN plane) and hard-tissue A, B and Pog points, lower lip, soft-tissue B, and pogonion points were greater, Wits appraisal was more negative, U1.PP was higher, IMPA was lower, and soft-tissue chin (Pog-Pog') was thicker in Group 1 when compared to Group 2 ($p<0.05$). Moreover, upper lip and subnasal (A-A') thicknesses were decreased, and chin thickness (Pog-Pog') was increased significantly ($p<0.05$).

Conclusion: Dentoskeletal characteristics of an ideally-treated Class III surgery patient differed from a Class I subject concerning a protrusive maxilla and soft-tissue pogonion, and incisors that were not fully-decompensated. Soft-tissues hindered the actual surgical correction to 66% and 73% in the mid- and lower-faces, respectively.

Keywords: Orthognathic surgery, skeletal Class III, surgical treatment, soft-tissue response

INTRODUCTION

Craniofacial growth in Class III patients differs from Class I subjects with regard to the anatomical differences at the cranial base where the maxilla is attached to and the glenoid fossa where the mandible articulates, the intrinsic growth potentials of the maxilla and mandible, and genetic and environmental factors affecting the growth of the nasal cartilage and condyles. These factors play important roles in the spatial and morphologic features of the jaws.[1-3] Moreover, thickness, mobility, and tonicity of the soft-tissues change with the functional needs of the patient and alter the contraction patterns of the facial muscles.[4] In addition to the dissimilarities in the hard- and soft-tissues, changes in the maxillary and mandibular incisor inclinations to conceal the underlying

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skeletal discrepancy further differentiate these individuals from one another.[5]

Orthognathic surgery can be considered the art of medical architecture that resculpts the dentoskeletal infrastructure of the face toward a more esthetic and functional state. The norms leading to an esthetic appearance are well-defined in the literature; however, the way to achieve it from skeletal and dental perspectives is highly singular. For a few decades now, orthodontists and maxillofacial surgeons have been using cephalometric prediction software to plan the final positions of the jaws while seeing the predicted outcome simultaneously. However, some anatomical factors, such as soft-tissue response or the original contours of the hard-tissues, introduce uncertainty to the predicted surgical outcome; therefore, it is important to apprehend inherent differences between skeletally harmonious and surgically-treated Class III subjects to set realistic goals.[6-8] Previous studies have shown drastic improvement in Class III facial profile with surgical-treatment, and analyzed soft-tissue response and its contribution to the final outcome.[4,9-12] The results of these studies demonstrated that soft-tissues covering the maxillary structures were less responsive than those covering the mandible, and mandible and lower lip were dominantly responsible for the improvement in the profile. However, the similarities of hard- and soft-tissue characteristics between surgically-treated Class III patients and Class I subjects are seldom studied.

Therefore, the aims of this study were: (1) to define dental and skeletal features beneath an ideally-treated Class III surgery patient, and compare these with skeletally harmonious control subjects, and (2) to show how soft-tissues respond to surgical jaw movements and contribute to the outcome.

METHODS

Formal approval from the Institutional Review Board of Başkent University (project no: D-KA22/24, date: 17.05.2022) was obtained, and the study was conducted protecting rights and interests of the research participants. Sample size calculation based on the difference in SNA-angle between skeletally Class I and Class III subjects, as shown in the study by Guyer et al.[13] showed that 50 subjects were needed in each group to reach 95% power with 5% Type I error (SPSS for Windows 22.0, SPSS Inc, Illinois, USA).

This retrospective study included orthodontic records of 50 ideally-treated orthognathic surgery patients who underwent double-jaw surgery for correcting skeletal Class III malocclusion (Group 1), and 50 control subjects (Group 2), all of whom were of European descent. Inclusion criteria for Group 1 were patients who (1) had ideal soft-tissue profiles at the end of treatment according to both Holdaway (N'-Pog'-UL, 7º-14º) and soft-tissue convexity angles (Gl'-Pronasale-Pog', 128.4º-136.4º), and (2) were normodivergent according to GoGn. SN angle (26º-38º) and upper-to-lower face harmony (Gl'-Sn:Sn-Me') (93.5%-103.5%) at the beginning of treatment, and (3) were fully decompensated before surgery, i.e., who were not treated with surgery-first or surgery-modified approaches. Exclusion criteria were patients (1) who had severe asymmetry, (2) presenting craniofacial syndromes, and (3) who had undergone major (rhinoplasty, etc.) or minor surgeries (filler injections, etc.) of the maxillofacial region during treatment, other than orthognathic surgery. A sex- and age-matched control group (Group 2), who presented dental and skeletal Class I malocclusion with minor incisor crowding, and whose Holdaway and soft-tissue convexity angles, as well as GoGn. SN angle and upper-to-lower face harmony values were within the normal range was studied for intergroup comparisons.

Lateral cephalometric radiographs taken at the beginning of treatment (T0), before surgery (T1) and at the end of treatment (on the debonding session) (T2) for Group 1, and at T0 for Group 2 were digitally traced and analyzed using Dolphin Imaging software (Vers 11.5 Premium, Patterson Dental, CA, USA). By the time of debonding in Group 1, soft-tissues had already recovered from surgery-induced edema. A total of 29 cephalometric variables were measured by the same investigator (Figure 1).

Three weeks after the initial data assessment, randomly chosen cephalometric radiographs of 10 patients from each group were re-traced by the same investigator for intraexaminer reliability.

Statistical Analysis

Statistical analyses were performed using the SPSS software package (SPSS for Windows 22.0, SPSS Inc, Illinois, USA). As the data were not normally-distributed, Mann-Whitney U and Wilcoxon signed-rank tests were used to compare differences between and within groups. The level of significance was set at $p<0.05$.

Intraclass correlation coefficients calculated to assess intraexaminer reliability ranged between 0.901 and 0.986.

RESULTS

Mean age at the beginning of treatment in Group 1 was 21.1 ± 4 years [minimum-maximum (min.-max.), 15.6-32.3 years], and Group 2 was 21.8 ± 4.2 years (min.-max., 15.7-33.3 years). Both groups comprised 27 female and 22 male patients. Patients in both groups were either at the R_U stage according to hand-and-wrist films[14], or at the 5th or 6th stage according to the cervical vertebral maturation method[15].

Cephalometric parameters are compared between the groups, and the results are presented in Table 1. Parameters that were similar between the groups at T0 were A-VRP (mm), PP.SN (º), occlusal plane. SN (º), overbite (mm), lower lip thickness (mm), and B-B' (mm). Parameters that were similar between the groups at T1 were U1-NA (mm), U1.PP (º), and L1.NB (º).

Parameters that showed significant differences between the surgery group at T2 and the control group were as follows: hard-tissue A point, hard- and soft-tissue B and Pog points, and

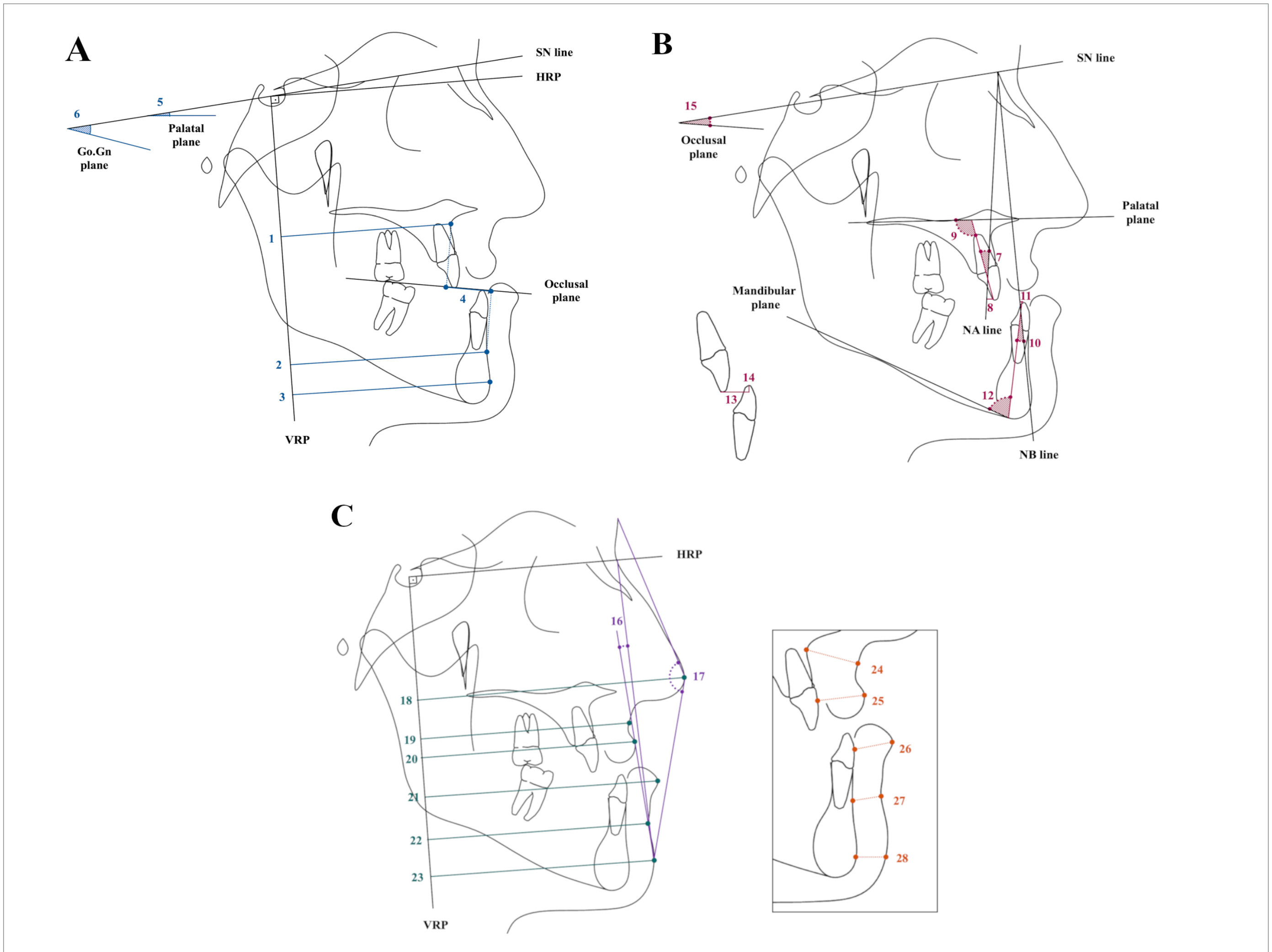

Figure 1. Reference planes and cephalometric variables used in the study. Reference planes; SN (Sella-Nasion) line; Horizontal reference plane (HRP), horizontal plane angulated 7° clockwise to the SN plane at Sella; Vertical reference plane (VRP), perpendicular plane to the HRP passing through Sella; Palatal (ANS-PNS) plane (PP); Occlusal plane, passing through mesiobuccal cusp tips of the first molars and incisal edges of the central incisors; NA line; NB line; Mandibular (Go-Me) plane. Cephalometric variables; **A,** 1, A-VRP; 2, B-VRP; 3, Pog-VRP; 4, Wits appraisal; 5, SN.PP; 6, Go.Gn.SN; **B,** 7; U1.NA; 8, U1-NA; 9, U1.PP; 10, L1.NB; 11, L1-NB; 12, IMPA; 13, Overjet; 14, Overbite; 15. Occlusal plane.SN; **C,** 16, Holdaway angle (N′-Pog′-UL); 17, Soft-tissue convexity angle (Gl′-Pronasale-Pog′); 18, Pronasale-VRP; 19, A′-VRP; 20, Upper lip-VRP; 21, Lower lip-VRP; 22, B′-VRP; 23, Pog′-VRP; 24, Subnasal thickness (A-A′); 25, Upper lip thickness; 26, Lower lip thickness; 27, Suprachin thickness (B-B′); 28, Chin thickness (Pog-Pog′)

lower lip were more protruded, and soft-tissue chin (Pog-Pog′) was thicker in Group 1. Furthermore, Wits appraisal was more negative, U1.PP (°) was higher and IMPA (°) was lower in Group 1 compared to Group 2.

Table 2 presents the amount and significance of changes in Group 1 between T1-T0 and T2-T1. The amount of advancement at the A point was 3.8 mm, whereas the amount of setback at the B and Pog points were 4.6 and 5.9, respectively. Maxillary incisors were retroclined for 2.7° and then proclined for 2.9° between T1-T0 and T2-T1, respectively. Mandibular incisors, on the other hand, were proclined for 12.2° between T1-T0 and then retroclined for 4.7° between T2-T1. Overjet was decreased by 3.7 mm between T1-T0 and then increased by 9.6 mm between T2-T1. Inclinations of both the palatal and occlusal planes relative to the SN plane increased. Soft-tissue parameters Holdaway and soft-tissue convexity angles improved toward a more convex profile between T2-T1. Pronasale, A′ point, and upper lip moved anteriorly, while the lower lip, B′ and Pog′ points moved posteriorly between T2-T1, all of which were statistically significant. Meanwhile, upper lip thickness and A-A′ decreased, and Pog-Pog′ increased significantly between T2-T1.

DISCUSSION

This study was conducted to investigate the dental and skeletal components of an esthetically pleasing soft-tissue profile achieved with double-jaw surgery in Class III patients, and to compare them with normal values acquired from skeletally harmonious subjects, while studying the effects of soft-tissues on the outcome. To do so, Class III surgery patients with ideal final soft-tissue profiles were selected from our university archive, and dentoskeletal characteristics were studied at 3 timepoints. A sex- and age-matched control group with the same ethnic origin was further identified to obtain reference

Table 1. Intergroup comparisons between the control (C) and orthognathic surgery (OS) groups at the beginning of treatment (T0), before surgery (T1) and at the end of treatment (T2) by Mann-Whitney U test

	Control (C) (n=49)	Orthognathic surgery (OS) (n=49)			Between groups		
	T0	T0	T1	T2	C & OS T0	C & OS T1	C & OS T2
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	p value	p value	p value
Skeletal							
A - VRP (mm)	63.5 ± 3.9	62.2 ± 4.2	62.2 ± 4.3	66 ± 3.9	0.305	0.315	**0.013***
B - VRP (mm)	58.2 ± 4.7	68.2 ± 5.4	67.8 ± 4.8	63.3 ± 4.4	**0.0001***	**0.0001***	**0.0001***
Pog - VRP (mm)	61.7 ± 4.6	70.9 ± 3.9	69.7 ± 4.1	63.9 ± 3.8	**0.001***	**0.001***	**0.01***
Wits appraisal (mm)	-0.4 ± 2.6	-11 ± 4	-12.4 ± 3	-3.6 ± 2.5	**0.0001***	**0.0001***	**0.0001***
GoGn. SN (°)	32 ± 3	32.7 ± 3.8	33.2 ± 3.6	33.4 ± 3.2	0.256	0.077	0.053
SN . PP (°)	7.8 ± 3.1	7.5 ± 3.9	7.4 ± 4.1	10.7 ± 4.1	0.909	0.529	0.196
Dental							
U1 . NA (°)	25 ± 6.2	30.1 ± 6.7	27.4 ± 6.7	27.1 ± 6.6	**0.0001***	**0.048***	**0.048***
U1 - NA (mm)	4.9 ± 2.2	7.2 ± 2.5	5.7 ± 2.6	4.8 ± 2.1	**0.0001***	0.058	0.924
U1 . PP (°)	113.6 ± 6.9	116.5 ± 6.7	113.8 ± 8.2	116.7 ± 7.1	**0.043***	0.665	**0.016***
L1 . NB (°)	25.7 ± 4.7	16.1 ± 6.8	27.3 ± 5.7	21.5 ± 5.5	**0.001***	0.091	**0.0001***
L1 - NB (mm)	4.9 ± 1.7	2.9 ± 2.2	5.6 ± 1.8	4.4 ± 1.7	**0.0001***	**0.045***	0.208
IMPA (°)	92.8 ± 5.6	75.8 ± 7.6	88 ± 5.8	83.2 ± 6.6	**0.0001***	**0.0001***	**0.0001***
Overjet (mm)	3 ± 1.2	-2.9 ± 2.7	-6.6 ± 2.4	3 ± 0.7	**0.0001***	**0.0001***	0.784
Overbite (mm)	1.3 ± 1.9	0.9 ± 2.7	0.9 ± 1.8	1.7 ± 0.6	0.332	0.131	0.161
Occlusal plane SN (°)	15.4 ± 4	13.9 ± 4.1	16.4 ± 3.9	19.2 ± 3.4	0.071	0.386	0.443
Soft tissue							
Holdaway angle (°)	12.2 ± 2	4.9 ± 3.6	4.5 ± 3.3	11 ± 2.3	**0.0001***	**0.0001***	0.443
Soft tissue convexity angle (°)	130.5 ± 3	139.3 ± 4.9	139.4 ± 4.9	132 ± 4.3	**0.0001***	**0.0001***	0.567
G'-Sn : Sn-Me' (%)	98.6 ± 8.9	95.5 ± 7.9	94.6 ± 8.1	93.7 ± 7.9	0.189	0.079	0.067
Pronasale - VRP (mm)	95 ± 6.4	93.1 ± 5.9	93 ± 5.9	94.1 ± 5.7	**0.001***	**0.001***	0.143
A' - VRP (mm)	76.2 ± 5.9	74.7 ± 5.7	73.5 ± 5.4	76 ± 5.6	**0.001***	**0.001***	0.143
UL - VRP (mm)	79.8 ± 6.5	78.4 ± 6.1	77.8 ± 6.2	79.8 ± 5.6	**0.001***	**0.001***	0.147
LL - VRP (mm)	76.9 ± 7.2	84.1 ± 7	85 ± 7.3	81 ± 6.3	**0.0001***	**0.0001***	**0.003***
B' - VRP (mm)	74.3 ± 6.9	83.2 ± 7.4	82.2 ± 7.6	77.7 ± 7.6	**0.0001***	**0.0001***	**0.001***
Pog' - VRP (mm)	71.2 ± 8	81.4 ± 8.2	80.8 ± 8.3	76.5 ± 7.2	**0.0001***	**0.0001***	**0.001***
A - A' (mm)	15.6 ± 2.1	16.7 ± 2	16.3 ± 1.8	14.9 ± 1.5	**0.014***	**0.041***	0.149
UL thickness (mm)	13.9 ± 2.1	16 ± 2.7	16.7 ± 2.3	14.3 ± 1.8	**0.0001***	**0.0001***	0.275
LL thickness (mm)	14.8 ± 1.4	14 ± 1.7	14.3 ± 1.7	14.2 ± 1.7	0.471	0.789	0.563
B - B' (mm)	11.5 ± 1.8	11.2 ± 1.3	11.1 ± 1.6	11.2 ± 1.4	0.994	0.327	0.765
Pog - Pog' (mm)	10.3 ± 2.3	13.1 ± 2.2	13 ± 2.1	14.4 ± 2.2	**0.014***	**0.001***	**0.001***

*$p<0.05$; HRP, horizontal reference plane; LL, lower lip; PP, palatal plane; SD, standard deviation; SN, Sella-Nasion line; UL, upper lip; VRP, vertical reference plane

values for comparisons. Soft-tissue profile was screened using two different parameters: Holdaway (N'-Pog'-UL) and soft-tissue convexity angles (Gl'-Pronasale-Pog'), and expected to be ideal according to both. The reason for using these particular parameters can be explained with the fact that they focus on key landmarks that define profile esthetics (Pog' & UL, Pog' & Pronasale) with respect to stable reference points (N'and Gl'). Furthermore, patients with a normodivergent facial type were preferred to investigate sagittal changes without being diminished or exaggerated by vertical and/or rotational jaw movements, and to eliminate the effect of increased vertical growth on the morphology of the maxilla.

Cephalometric parameters in surgery patients deviate acutely from ideal values and tend to approximate to the norms after surgical treatment. As opposed to this, although the horizontal distance of hard-tissue A point to VRP (A-VRP) was similar to that of the control group, the maxilla had to be advanced for 3.8 mm, and its final position was beyond the upper limit of the normal range. However, the soft-tissue profile was rather esthetically

Table 2. Comparison of the changes in the orthognathic surgery group before surgery (T1-T0) and after surgery (T2-T1) by Wilcoxon signed-rank test

	T0	T1	T2	T1-T0		T2-T1	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	p value	Mean ± SD	p value
Skeletal							
A - VRP (mm)	62.2 ± 4.2	62.2 ± 4.3	66 ± 3.9	0 ± 0.4	0.865	3.8 ± 2	**0.0001***
B - VRP (mm)	68.2 ± 5.4	67.8 ± 4.8	63.3 ± 4.4	-0.4 ± 0.9	0.237	-4.6 ± 3	**0.0001***
Pog - VRP (mm)	70.9 ± 3.9	69.7 ± 4.1	63.9 ± 3.8	-1.3 ± 1.1	0.089	-5.9 ± 2.7	**0.0001***
Wits appraisal (mm)	-11 ± 4	-12.4 ± 3	-3.6 ± 2.5	-1.4 ± 2.1	0.059	8.8 ± 2.7	**0.0001***
GoGn . SN (°)	32.7 ± 3.8	33.2 ± 3.6	33.4 ± 3.2	0.5 ± 2.8	0.197	0.2 ± 3.4	0.641
PP . SN (°)	7.5 ± 3.9	7.4 ± 4.1	10.7 ± 4.1	-0.2 ± 1.1	0.897	3.3 ± 2.6	**0.003***
Dental							
U1 . NA (°)	30.1 ± 6.7	27.4 ± 6.7	25.6 ± 6.6	-2.7 ± 3.2	**0.008***	-1.8 ± 6	**0.039***
U1 - NA (mm)	7.2 ± 2.5	5.7 ± 2.6	4.8 ± 2.1	-1.5 ± 2.3	**0.0001***	-0.9 ± 2	**0.002***
U1 . PP (°)	116.5 ± 6.7	113.8 ± 8.2	116.7 ± 7.1	-2.7 ± 3.1	**0.01***	2.9 ± 5.7	**0.002***
L1 . NB (°)	16.1 ± 6.8	27.3 ± 5.7	21.5 ± 5.5	11.3 ± 7.7	**0.0001***	-5.8 ± 4.9	**0.0001***
L1 - NB (mm)	2.9 ± 2.2	5.6 ± 1.8	4.4 ± 1.7	2.7 ± 1.7	**0.0001***	-1.2 ± 1.2	**0.0001***
IMPA (°)	75.8 ± 7.6	88 ± 5.8	83.2 ± 6.6	12.2 ± 6.9	**0.0001***	-4.7 ± 4.4	**0.0001***
Overjet (mm)	-2.9 ± 2.7	-6.6 ± 2.4	3 ± 0.7	-3.7 ± 2.2	**0.0001***	9.6 ± 2.4	**0.0001***
Overbite (mm)	0.9 ± 2.7	0.9 ± 1.8	1.7 ± 0.6	0 ± 2.2	0.728	0.8 ± 1.7	**0.003***
Occ plane . SN (°)	13.9 ± 4.1	15.4 ± 3.9	19.2 ± 3.4	1.6 ± 3	**0.0001***	3.8 ± 3.2	**0.0001***
Soft tissue							
Holdaway angle (°)	4.9 ± 3.6	4.5 ± 3.3	11 ± 2.3	-0.4 ± 2.3	0.162	6.5 ± 2.7	**0.0001***
Soft tissue convexity angle (°)	139.3 ± 4.9	139.4 ± 4.9	132 ± 4.3	0.1 ± 2.5	0.98	-7.4 ± 2.7	**0.0001***
G'-Sn : Sn-Me' (%)	95.5 ± 7.9	94.6 ± 8.1	93.7 ± 7.9	-0.9 ± 5.5	0.124	-0.9 ± 7.2	0.456
Tip of nose - VRP (mm)	93.1 ± 5.9	93 ± 5.9	94.1 ± 5.7	-0.1 ± 1.1	0.787	1 ± 1.4	**0.0001***
A' - VRP (mm)	74.7 ± 5.7	73.5 ± 5.4	76 ± 5.6	-1.1 ± 1.1	**0.001***	2.5 ± 1.1	**0.0001***
UL - VRP (mm)	78.4 ± 6.1	77.8 ± 6.2	79.8 ± 5.6	-0.6 ± 1.9	**0.017***	2 ± 2.4	**0.0001***
LL - VRP (mm)	84.1 ± 7	85 ± 7.3	81 ± 6.3	0.9 ± 2	**0.003***	-4 ± 2.8	**0.0001***
B' - VRP (mm)	83.2 ± 7.4	82.2 ± 7.6	77.7 ± 7.6	-0.9 ± 1.1	**0.01***	-4.5 ± 2.3	**0.0001***
Pog' - VRP (mm)	81.4 ± 8.2	80.8 ± 8.3	76.5 ± 7.2	-0.7 ± 1.8	**0.02***	-4.3 ± 3.5	**0.0001***
A - A' (mm)	16.7 ± 2	16.3 ± 1.8	14.9 ± 1.5	-0.3 ± 1.2	0.079	-1.4 ± 1.4	**0.0001***
UL thickness (mm)	16 ± 2.7	16.7 ± 2.3	14.3 ± 1.8	0.7 ± 3.1	0.281	-2.4 ± 1.5	**0.0001***
LL thickness (mm)	14 ± 1.7	14.3 ± 1.7	14.2 ± 1.7	0.3 ± 1.6	0.131	-0.1 ± 1.6	0.568
B - B' (mm)	11.2 ± 1.3	11.1 ± 1.6	11.2 ± 1.4	-0.1 ± 1.1	0.596	0.1 ± 0.9	0.325
Pog - Pog' (mm)	13.1 ± 2.2	13 ± 2.1	14.4 ± 2.2	-0.2 ± 1.2	0.315	1.5 ± 1.2	**0.0001***

*p<0.05; HRP, horizontal reference plane; LL, lower lip; PP, palatal plane; SD, standard deviation; SN, Sella-Nasion line; UL, upper lip; VRP, vertical reference plane

pleasing at the end of the treatment, but not over-convex. This finding indicates that there may be morphological differences between the anterior contours of ideally-grown and skeletally-deficient maxillae, the latter being flat and lacking curvature to provide enough fullness. Bearing in mind that maxillary advancement may not fully address the mid-facial deficiency, adjunctive procedures to augment the mid-face such as fat grafts, dermal fillers, or implants can also be included in the treatment plan. However, a treatment strategy involving more maxillary advancement and less mandibular set-back is advantageous in obtaining a well-supported mid-face that seems more defined and youthful, as well as reducing submandibular sagging.[16] Furthermore, as the volume of the functioning spaces is characterized by metabolic and functional demands of the body, the risk of relapse can be reduced effectively by preserving the airway volume and tongue space.[17-19]

Soft-tissue characteristics and response against surgical jaw movements is another critical determinant of the outcome, because they may diminish the amount of skeletal correction either by compression and thinning or by relaxation and thickening.[9,10,12] As the original thickness and tonicity of the soft-tissues determine how closely they will follow the hard tissues, pretreatment soft-tissue thicknesses were also studied for comparison.[20,21] According to our results, pretreatment (T0) subnasal (A-A') and upper lip thicknesses, as well as, chin thickness (Pog-Pog′) were thicker in the surgery group; yet, lower lip and suprachin (B-B′) thicknesses were similar between the groups. Furthermore, between T2-T1, subnasal (A-A′) and upper lip thicknesses tended to decrease with maxillary advancement, while soft-tissue chin thickness increased, and lower lip and suprachin thicknesses remained stable after mandibular surgery.

In the maxilla, the ratio of soft to hard tissue changes was 66%, which means that a critical one-third of the maxillary advancement was lost with thinning of the soft-tissues. In line with this finding, many studies have shown that soft-tissue response was weaker in the maxilla compared to the mandible after surgery.[4,10,11] This can be explained with the resection of the anterior nasal spine during surgery and the incision scars limiting upper lip movement,[9-12] but also with the dead space between the maxillary incisors and the upper lip that delays upper lip movement until this gap is filled with maxillary advancement.[20]

The sagittal position of the chin in the surgery group was never similar to that of the control group, and, although statistically insignificant, soft-tissue profile at the end of treatment was less convex in this group. This can be explained with a lesser need for mandibular set-back because of more maxillary advancement, and with the response of soft-tissues covering the lower face. As opposed to the maxilla, the mandibular soft-tissues became thicker as the mandible was set back, which manifested itself as 1.5 mm increase in the chin thickness (Pog-Pog′). The ratio of soft to hard tissue changes was 73%, showing that almost one-fourth of the mandibular set-back did not project on the final soft-tissue profile. This finding is in general agreement with the studies of Chew[11] and Altug-Atac et al.[12].

Mandibular incisors were slightly compensated, yet significantly different from the control group before surgery (T1). They further retroclined during the post-surgical treatment phase (T2-T1) and lost approximately 40% of the decompensatory proclination. This finding is in agreement with the previous studies that have shown that dental relapse was positively correlated with the amount of tooth movement.[22,23] However, even though mandibular incisors were retroclined (83.2° ± 6.6°) compared to the Class I subjects (92.8° ± 5.6°), the soft-tissue profile and sagittal position of the lower lip were ideal at the end of treatment.

Study Limitations

This study was conducted on 2-dimensional data. Blinding was impossible for data collection; however, the data assessor was blinde; therefore, detection bias can be considered low.

CONCLUSION

Class III surgery patients with an ideal post-treatment soft-tissue profile differed from Class I subjects with a protrusive maxilla and a prominent soft-tissue pogonion.

Soft-tissues responded to the surgical jaw movements in a counter-active manner and diminished the actual surgical correction, which may have clinical implications when planning the new positions of the jaws. The decrease in the upper lip and increase in the chin thicknesses led to the loss of one-third and one-fourth of the surgical correction in the mid- and lower-faces, respectively.

Mandibular incisors were slightly compensated before surgery, and further lost a marked amount of decompensatory proclination after surgery without adversely affecting the outcome.

Ethics

Ethics Committee Approval: This study was approved by the Institutional Review Board of Başkent University (project no: D-KA22/24, date: 17.05.2022).

Informed Consent: The study was conducted protecting rights and interests of the research participants.

Peer-review: Externally and internally peer-reviewed.

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