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Outcomes of early versus late treatment of severe Class II high-angle patients

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Introduction: The aim of this work was to compare the skeletal and dental outcomes of 1- versus 2-phase treatment in Class II subjects with difficult-to-treat high-angle severe Class II malocclusions. **Methods:** The sample of 120 cases was collected from the private offices of 3 experienced clinicians. The following selection criteria were used: (1) ANB $\geq 6^\circ$, (2) SN-GoGn $\geq 37^\circ$ or mandibular plane to Frankfort horizontal plane $\geq 30^\circ$; and (3) overjet ≥ 6 mm. Patients were classified into either the early or the late treatment group according to dental age (early Tx: ≥ 5 primary teeth; late Tx: otherwise). Thirty-four angular, linear, and proportional measurements were determined for each patient. Statistical significance was assessed with the use of a 2-tailed *t* test, analysis of covariance test, and chi-square test. **Results:** The results showed that early 2-phase treatment for severe Class II high-angle patients offered no skeletal anteroposterior advantages over late 1-phase treatment. Severe high-angle Class II patients also showed similar dental anteroposterior outcomes with the use of both approaches. Vertically there was a higher frequency of increased mandibular plane angles and extrusion of upper incisors and lower molars in the late treatment group. **Conclusions:** Early 2-phase treatment for severe Class II high-angle patients offered no skeletal or dental advantage over late 1-phase treatment. (Am J Orthod Dentofacial Orthop 2019;156:375-82)

The optimal timing of treatment for children with Class II malocclusions remains controversial. Factors such as the best time for correction of the skeletal discrepancy, the potential reduction of total treatment time, patient cooperation and overall cost must be considered. These complex questions are not easily solved owing to the multifactorial nature of different malocclusions, as well as the difficulty of standardizing treatment protocols between clinicians. Recent randomized controlled trials (RCTs) have attempted to control these confounding factors and showed no major differences between early and late treatment for the average Class II patient.[1-7]

In their RCT including 175 randomly assigned Class II subjects, Tulloch et al[6,7] found that early treatment appears to be less efficient in terms of reduction of the average treatment time and the need for later extractions. That study also reported that any differences created between the treated children and untreated control group by the phase 1 treatment before adolescence disappeared when both groups received comprehensive fixed appliance treatment during adolescence.

Researchers at the University of Florida also compared the effectiveness of early treatment with headgear and bionator treatment. Their RCT showed stability in skeletal improvement after the end of early treatment. When the peer assessment ratings from 1-phase and 2-phase treatment protocols were compared, both RCTs at the University of North Carolina and the University of Florida concluded that there was no difference in the average outcome score between the 2 treatment protocols.[1,3,6,8]

It is important to note that previous clinical trials, except for the one at the University of Florida, included all types of Class II patients. The studies were focused on "average" Class II patients. Their conclusions, therefore, cannot be extended to patients with severe Class II

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skeletal discrepancies and high mandibular planes. Even though the University of Florida study stratified subjects based on vertical discrepancies, they compared the outcomes between the 2 treatment protocols only in terms of molar relationship without a skeletal comparison. None of the RCTs specifically examined or controlled for mandibular plane (MP) angle.

A high MP angle has been an important predictor for treatment outcome because of the high potential for an unfavorable growth direction of the mandible.[9,10] Likewise, vertical control of maxillary growth is a crucial treatment goal for high-plane cases, along with the sagittal correction of the skeletal discrepancy.[11,12]

Creekmore[13] reported a diminished ability to produce a sagittal Class II correction for the high-angle patient owing to backward rotation of the mandible. He also suggested that the Class II pattern would tend to become more exaggerated with time if force systems were unfavorable. Other studies have supported the postulate that high-angle faces are more susceptible to vertical development than average faces.[11,14]

In this respect, it has been reported that the use of a high-pull or vertical-pull chin cup can control the vertical growth of the mandible and induce anterior growth of the mandible.[15,16] On the other hand, it has been reported that in patients with increased vertical dimension, the bionator and high-pull facebow combination resulted in the hyperdivergent facial pattern deteriorating in the anterior-posterior direction compared with the control group after the second phase of treatment.[17] Thus, to date no studies have reported on the efficacy of treatment for severe high-angle patients with Class II malocclusions.

The purpose of the present study, therefore, was to compare the skeletal and dental outcomes of 1- versus 2-phase treatments for Class II patients with severe high-angle Class II malocclusions.

MATERIAL AND METHODS

To identify Class II subjects suitable for this study, a total of 4,000 patient charts were examined in the private offices of 3 experienced clinicians in Seattle, Los Angeles, and Vancouver. Information such as age, sex, race, treatment start and end dates, total treatment time, extraction versus nonextraction, and appliance selection were recorded for each patient. A total of 660 Class II patients were identified, and a final sample of 120 patients were selected who met the following criteria: (1) ANB $\geq$6°; (2) either SN-GoGn $\geq$37° or FMA $\geq$30°; (3) bilateral molar relationship more than half-cusp Class I; and (4) overjet $\geq$6 mm.

Table I. Cephalometric measurements

Category	*Measurements*
AP-maxilla	SNA (°), maxillary skeletal (A-Na Perp, mm), midface length (Co-A, mm)
AP-mandible	SNB (°), mandibular length (Co-Gn, mm), mandibular skeletal (Pg-Na Perp, mm)
Maxilla to mandible	ANB (°), Wits Appraisal (mm), Mx/Md diff (Co-Gn-Co-A, mm)
Vertical	FMA (MP-FH, °), SN-GoGn (°), Y-Axis (SGn-SN, °), UFH/TFH (N-ANS:N-Me, %), LFH/TFH (ANS-Me:N-Me, %), U6-PP (UPDH, mm), L6-MP (LPDH, mm), U1-PP (UADH, mm), L1-MP (LADH, mm), occlusive plane to SN (°), palatal-mandibular angle (PP-MP,°), Ar-Gn (mm), anterior facial height (ANS-Me, mm), RH/LFH (ArGo/ANSMe, %)
Dental	Interincisal angle (U1-L1, °) overbite (mm), overjet (mm)
Upper incisor	U1-NA (°) U1-NA (mm), U1-SN (°)
Lower incisor	L1-NB (°) L1-NB (mm), FMIA (L1-FH, °), IMPA (L1-MP, °), L1 to A-Po (°)

The 660 patients were initially selected based on the fact that they were described as being Class II in the databases of the 3 offices. The cephalograms of all 660 patients were digitized and 300 patients met the selection criteria of severe Class II (ANB >6°; sample mean ANB 7.3°). The final 120 patients were selected solely on the availability of initial and final records. The clinicians treated the Class II patients when they presented either in the mixed dentition or in adolescence. The clinicians were not involved in the sample selection (office A: 35 patients; office B: 56 patients; office C: 31 patients).

The power was calculated as 0.76, assuming that the subject number of each group was 58, and the effect size and significance level were 0.5 and 0.05, respectively.

Thirty-seven angular, linear, and proportional measurements were calculated for each patient (Table I). All lateral cephalometric tracings were digitized by the same examiner with the use of Dolphin Cephalometric Orthodontic processing software. Ten randomly chosen lateral cephalograms were traced twice by the same examiner and measured separately to check measurement error. The measurement error ranged from 0.1 to 0.3 mm and 0.05° to 0.2°.

The mean ages for initiation of treatment for the early treatment group were 9.8 years for girls and 10.5 years for boys. The mean starting ages for the late treatment group were 11.6 years for girls and 12.3 years for boys.

Treatment during the first phase of orthodontic therapy had to have been initiated for patients with at least 5 primary teeth clinically visible. Furthermore, phase 1 treatment had to involve growth modification with the use of either headgear (combination or high-pull) or a functional appliance (Bionator).

Requirements for the late treatment group were fewer than 4 primary teeth clinically visible. To allow for significant growth potential, boys began their single phase of full appliance therapy before 14.5 years of age and girls before 13.5 years of age.

Phase 2 treatment began at the orthodontist's discretion, usually when the rest of the primary teeth had exfoliated. All patients were treated with the use of edgewise appliances. Each clinician followed his normal treatment techniques to produce the best possible results for the patient.

Statistical analysis

Analysis of variance with Bonferroni correction for multiple comparisons was used on skeletal and dental measures to assess the similarity of the data at the initial stage from each of the 3 offices. Independent *t* tests were used to compare early and late treatment groups at alpha 0.05. Relationships between outcomes (ANB, Wits, FMA, SN-GoGn at the end of treatment [T2]) and covariates were examined by means of analysis of covariance (ANCOVA). The office, sex, and treatment time were set as fixed factors, and age at the start of treatment (T1), ANB at T1, Wits at T1, FMA at T1, SN-GoGn at T1 were set as covariates. The relationship between treatment time and the change of MP were examined by means of chi-square and Fisher exact tests for categoric variables.

RESULTS

The sample consisted of 62 patients in the early treatment group and 58 patients in the late treatment group. There were 52 male and 68 female patients in this study, and the distributions of treatment type and sex were similar for each office (Table II).

The samples derived from the 3 offices were remarkably similar before treatment, with 35 of the 37 parameters showing no significant differences. This allowed the groups to be combined for greater power of statistical analyses. The 2 differences were an 0.8° greater initial ANB measurement for the patients from office A and a 1.4° greater SN-GoGn angle for the patients from office C.

The severity of the skeletal Class 2 malocclusion of the early and late treatment groups showed great pretreatment similarity; (ANB: early treatment 7.4°, late treatment 7.3°; Wits: early treatment 4.0 mm, late treatment 4.4 mm). The 2 groups also showed similar vertical relationships (FMA: early treatment 31.9°, late treatment 31.8°; SN-GoGn: early treatment 39.3°, late treatment 39.0°). As expected, because the sample was 2 years older, the late treatment group showed greater overall initial dimensions (Table III).

Table II. Sample ages

	Type of treatment							
	Early				*Late*			
	Male		*Female*		*Male*		*Female*	
Treatment time	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Initial age (y)	10.53	1.23	9.77	1.33	12.31	1.11	11.60	0.95
Final age (y)	15.72	1.41	14.93	1.57	15.46	1.03	15.36	1.43
Total treatment time (y)	5.18	1.32	5.16	1.53	3.14	1.01	3.76	1.25

At the end of treatment, 8 of the 9 skeletal anteroposterior measurements showed no significant differences between the early and late treatment groups. Similarly, 7 of the 8 skeletal vertical parameters were similar at T2. The 2 differences noted were that the ANB angle was 0.70° higher ($P < 0.05$) and the FMA angle 1.7° higher for the late treatment group. The late treatment group tended to show slightly increased dental heights and an increased lower facial height (ANS-Me) than the early treatment group (Table IV). Dentally, 10 of 11 measurements were found to be similar in the 2 groups, with only the late treatment group's FMIA showing a significant decrease (Fig 1).

Boys showed no difference in outcomes between the 2 groups for all dental and skeletal variables. Girls, in contrast, showed higher ANB value in the late treatment group, as well as more upright upper incisors (Table V).

In ANCOVA analysis for ANB, SN-GoGn, and FMA at T2, office, treatment time, and sex were insignificant ($P > 0.05$) when considering covariates. There was only 1 significant difference between the sexes ($F = 4.46$; $P = 037$) for Wits at T2.

To evaluate which variables were most influential on the change of MP, we sorted the groups by direction of the mandibular rotation occurring during the orthodontic treatment: (1) MP decreased by more than 2°; (2) MP plane changed less than +2° or −2°; of (3) MP change increased by >2°. It was found that 29% of the early treatment group and 9% of the late treatment group showed a decrease in MP angle, and 16% of the early treatment group and 28% of the late treatment group showed an increase in MP angle ($P < 0.05$; Fig 2). The odds of an unfavorable change in MP angle for the

Table III. Descriptive initial characteristics for early and late treatment groups

Measure		Early (n = 62)		Late (n = 58)		
		Mean	SD	Mean	SD	P
Maxilla	SNA (°)	80.3	3.2	81.3	3.0	0.731
	A-Na Perp (mm)	0.3	3.2	1.0	2.9	0.161
	Co-A (mm)	82.9	4.3	86.6	4.5	<0.001***
Mandible	SNB (°)	72.9	2.8	74.0	2.6	0.321
	Co-Gn (mm)	103.8	5.0	109.5	5.5	<0.001***
	Pg-Na-Perp (mm)	−13.7	5.4	−12.6	4.6	0.242
Anteroposterior relationship	ANB (°)	7.4	1.5	7.3	1.5	0.881
	Wits (mm)	4.0	2.3	4.4	2.8	0.381
	Mx/Mn diff (mm)	21.0	3.7	22.9	3.7	0.005**
Vertical relationship	FMA (°)	31.9	3.0	31.8	2.7	0.948
	SN-GoGn (°)	39.3	3.1	39.0	3.2	0.608
	Y axis (°)	72.6	3.2	72.6	2.7	0.967
	Ramus (°)	38.5	3.2	40.8	3.6	<0.001***
	PP-SN (°)	9.4	3.0	9.2	3.3	0.828
	Gonial angle (°)	133.8	4.3	133.6	4.6	0.784
	UFH/TFH (%)	44.6	1.8	44.8	2.2	0.603
	LFH/TFH (%)	55.4	1.8	55.2	2.2	0.603
	U6-PP (mm)	20.0	2.0	21.9	2.2	<0.001***
	L6-MO (mm)	29.5	2.2	30.5	2.2	0.014*
	U1-PP (mm)	28.7	2.6	30.4	2.3	<0.001***
	L1-MP (mm)	39.9	2.6	41.7	2.8	<0.001***
	Occ-SN (°)	22.0	3.6	20.8	3.7	0.066
	PP-MP (°)	32.5	3.0	32.3	3.8	0.811
	Ar-Gn (mm)	103.8	5.0	109.5	5.5	<0.001***
	ANS-Me (mm)	67.0	3.9	69.1	3.8	0.004**
	ArGo/ANSMe (%)	64.3	4.3	66.0	5.1	0.046*
Dental	U1-L1 (°)	129.3	9.4	124.3	9.7	0.005**
	OB (mm)	2	2.4	2.7	2.2	0.232
	OJ (mm)	7.2	1.5	7	1.5	0.520
	U1-Na (°)	18.9	5.6	20.3	5.7	0.201
	U1-Na (mm)	2.4	1.9	3.2	2.3	0.041*
	U1-SN (°)	99.2	6.6	101.6	6.7	0.542
	L1-NB (°)	24.4	6.1	28.2	6.3	0.005**
	L1-NB (mm)	5.5	2.3	7	2.2	0.006**
	FMIA (°)	58.5	6.5	55.5	6.6	0.032*
	IMPA (°)	89.6	5.8	92.6	6.3	0.004**
	L1-Apo (°)	16.2	5.2	19.8	4.7	<0.001***

*P <0.05; **P <0.01; ***P <0.001 (independent t tests).

late treatment group was 3.7 times greater than for the early treatment group ($P < 0.05$).

DISCUSSION

The purpose of this study was to retrospectively compare 1-phase and 2-phase treatment outcomes for patients who had severe Class II malocclusions and concomitant high MP angles. After treatment, the skeletal measurements of the early treatment group and late treatment group were very similar to each other. The results of this study, therefore, support the conclusions of previous studies, which found that the final treatment outcomes of early Class II treatment and late Class II treatment did not show any significant clinical differences.[1-7]

In the present study, a slightly greater amount of backward rotation of the mandible was observed after treatment in the late treatment group. Ghafari et al[2] and Baumrind et al[18,19] reported that the use of headgear in treating growing patients with a skeletal Class II malocclusion opened the MP angle approximately 1-2°, which is similar to the results of this study. Although this was only a very small amount, it is speculated that the increase of the MP angle in the late treatment group is due to extrusion of the posterior dentition.[20-22]

Table IV. Descriptive final characteristics for early treatment and late treatment groups

		Early (n = 62)		Late (n = 58)		
Measure		*Mean*	*SD*	*Mean*	*SD*	P
Maxilla	SNA (°)	78.7	3.2	79.2	3.4	0.370
	A-Na Perp (mm)	−1.2	4.0	−1.2	3.1	0.994
	Co-A (mm)	87.1	5.2	87.9	4.4	0.404
Mandible	SNB (°)	73.9	3.1	73.8	3.3	0.767
	Co-Gn (mm)	116.7	7.1	117.6	5.9	0.465
	Pg-Na-Perp (mm)	−12.1	6.8	−14.1	6.1	0.100
Anteroposterior relationship	ANB (°)	4.8	1.7	5.5	1.6	0.021*
	Wits (mm)	2.0	2.0	1.9	2.0	0.766
	Mx/Mn diff (mm)	29.6	4.9	29.7	4.0	0.862
Vertical relationship	FMA (°)	31.0	4.5	32.8	3.9	0.025*
	SN-GoGn (°)	38.9	4.5	39.9	4.0	0.186
	Y axis (°)	73.4	3.6	74.3	3.1	0.141
	Ramus (°)	45.0	5.6	45.4	4.9	0.465
	PP-SN (°)	10.0	3.4	10.0	3.3	0.424
	Gonial angle (°)	131.7	4.5	132.1	5.0	0.091
	UFH/TFH (%)	44.0	2.0	43.9	1.9	0.950
	LFH/TFH (%)	56.0	2.0	56.1	1.9	0.950
	U6-PP (mm)	24.4	2.3	25.2	2.1	0.049*
	L6-MO (mm)	34.0	2.9	35.1	2.9	0.045*
	U1-PP (mm)	31.3	2.9	32.3	2.2	0.032*
	L1-MP (mm)	44.0	3.2	44.4	2.9	0.442
	Occ-SN (°)	20.9	4.4	22.3	4.4	0.074
	PP-MP (°)	31.3	4.3	32.5	4.4	0.146
	Ar-Gn (mm)	116.7	7.1	117.6	5.9	0.465
	ANS-Me (mm)	73.9	5.3	75.7	4.3	0.049*
	ArGo/ANSMe (%)	67.9	5.7	66.8	6.6	0.363
Dental	U1-L1 (°)	127.3	8.1	127.2	7.7	0.243
	OB (mm)	1.7	1.0	1.4	1.2	0.432
	OJ (mm)	3.0	0.7	3.0	0.8	0.201
	U1-Na (°)	19.9	5.5	17.8	6.7	0.081
	U1-Na (mm)	2.4	2.1	1.7	2.5	0.212
	U1-SN (°)	98.6	6.0	97.0	7.2	0.423
	L1-NB (°)	28.0	6.0	29.6	4.3	0.123
	L1-NB (mm)	6.8	2.1	7.3	1.7	0.112
	FMIA (°)	56.2	6.0	53.9	5.8	0.032*
	IMPA (°)	92.8	6.4	93.3	5.4	0.762
	L1-Apo (°)	23.1	4.2	23.6	3.9	0.234

*P <0.05 (independent t tests).

Although the overall MP angle remained almost unchanged during treatment, 16% of the subjects in the early treatment group and 28% in the late treatment group showed backward mandibular rotation. Patients showing mandibular closure, on the other hand, represented 29% and 9% of the early and late treatment groups, respectively. These results contrast with the results of previous RCTs, which reported no significant difference between the 2 groups regarding MP angle.[1,3] However, those previous studies did not consider the skeletal changes in the vertical dimension, and only the correction of molar relationship was evaluated.

Because of the absence of a control group, it is unclear whether the increase in the MP angle was due to treatment or individual growth pattern. Schudy[23] thought that the inclination of the MP could be a good indicator of mandibular rotation. A small MP-SN angle would indicate that the mandible had rotated forward, whereas a large angle would be a sign of backward rotation. However, recent studies indicated that true "posterior rotators" occur more rarely than had been previously assumed. Chung and Wond[24] studied the growth patterns of skeletal Class II malocclusion patients who did not receive orthodontic treatment and classified them according to MP angle. Karlsen[25] also reported that the matrix rotation of the high-angle group was equal to the matrix rotation rate of the low-angle group. Based on the results of those studies, the rotation

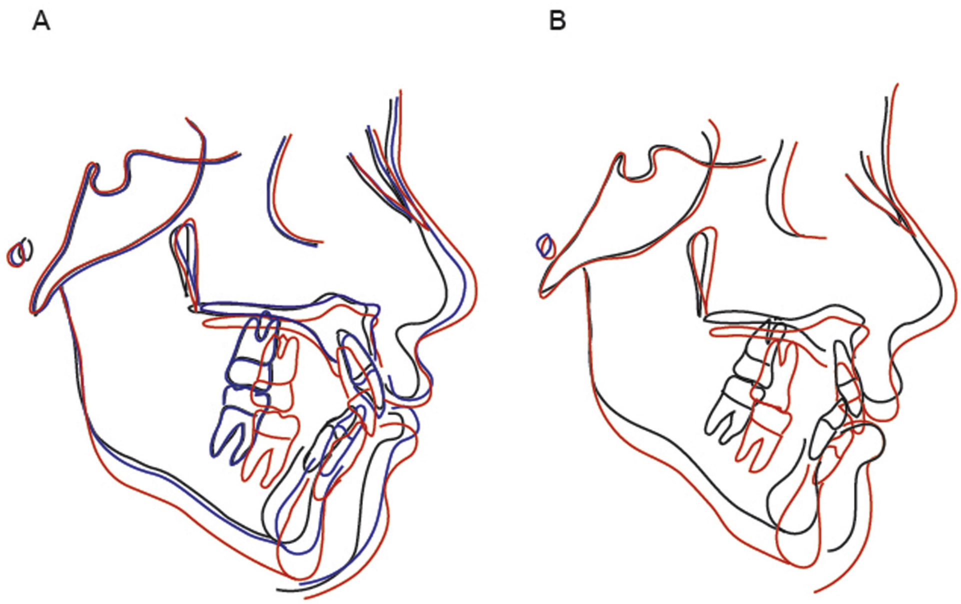

Fig 1. A Comparison of the pre-post superimposed cephalometric tracings from the early and late treatment groups: **A,** before (*black*), during (*blue*), and after (*red*) treatment from a typical subject in the early treatment group; **B,** before (*black*) and after (*red*) treatment from a typical subject in the late treatment group.

Table V. Final descriptive characteristics by sex

		Male					*Female*				
		Early Tx		*Late Tx*			*Early Tx*		*Late Tx*		
Measure		*Mean*	*SD*	*Mean*	*SD*	P	*Mean*	*SD*	*Mean*	*SD*	P
Horizontal	SNA (°)	78.9	3.4	79.0	3.1	0.938	78.6	3.0	79.5	3.7	0.269
	SNB (°)	73.8	2.7	73.6	2.6	0.714	74.0	3.4	73.9	3.8	0.939
	ANB (°)	5.0	1.8	5.4	1.4	0.448	4.6	1.6	5.6	1.8	0.022*
Vertical	FMA (°)	30.4	4.3	32.0	3.6	0.133	31.5	4.7	33.5	4.1	0.065
	SN-GoGn (°)	38.2	4.7	39.0	3.4	0.427	39.3	4.3	40.7	4.4	0.200
	U6-PP (mm)	25.1	2.1	25.8	2.5	0.276	24.0	2.4	24.7	1.5	0.183
	L6-MO (mm)	35.1	3.2	35.8	3.2	0.491	33.2	2.5	34.4	2.4	0.060
	U1-PP (mm)	32.0	2.9	32.8	2.5	0.300	30.8	2.8	31.9	1.9	0.087
	ANS-Me (mm)	75.9	5.4	77.0	4.9	0.465	72.7	4.9	74.5	3.4	0.103
Dental	U1-Na (°)	18.9	5.1	18.9	6.9	0.986	20.5	5.7	16.7	6.5	0.012*
	U1-SN (°)	97.7	5.2	97.9	6.8	0.979	99.1	6.5	96.2	7.5	0.089
	L1-NB (°)	27.7	6.6	30.1	3.6	0.104	28.2	5.6	29.1	4.9	0.552
	IMPA (°)	93.4	6.5	94.8	4.5	0.351	92.5	6.3	91.9	5.8	0.725

Tx, treatment.
*$P < 0.05$ (independent *t* tets).

pattern observed in the present study can be considered a side-effect of orthodontic treatment; however, there is still debate as to the nature of mandibular rotation after treatment of Class II high-angle cases.[22,26]

The sample analyzed in this study had MP angles that were 7° higher than accepted norms and would be thought of by most clinicians as reflecting high MP angle cases. The patients were not selected based on long faces and did not have as high MP angles as seen in some long face studies.[27]

Vertical changes in the dentition were observed in both early and late treatment groups. Especially in the late treatment group, additional extrusion of about 1 mm was observed in the upper anterior dentition

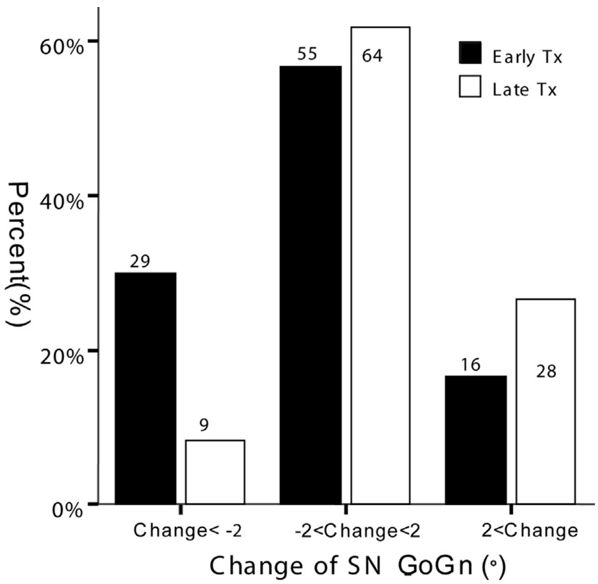

Fig 2. Percentages of unfavorable changes of the mandibular plane by treatment group.

and the lower posterior dentition. Undesirable increases of MP and lower facial height can be caused even in growing children by excessive extrusion of teeth over the capacity of vertical growth of the mandible during orthodontic treatment. This is sometimes an inevitable consequence of compensating for severe skeletal AP discrepancies.[26,28,29] This scenario can be supported by the data from our late treatment group, which showed significant extrusion of the upper incisors and lower molars. Accordingly, more anteroposterior discrepancy was found in the late treatment group.

Although these small differences tell clinicians who want to practice evidence-based orthodontics that there is little statistical difference between the 2 groups, our individual clinical results are often measured small degrees and millimeters and can represent a big difference to a clinician with an individual patient. In addition, because this study assesseded only lateral cephalometric (2D) measurements, future studies should evaluate other questions, such as whether the occlusion is different in each group, smile esthetics, facial balance, airway, stability, etc.

In this study, it was interesting to note that there were differences in skeletal and dental outcomes after treatment between the 2 sexes. In the late treatment group, girlss showed a higher ANB value after treatment and relatively more lingual tipping and extrusion of the upper incisors. These dental changes may be correlated with the dental compensation that occurs when skeletal horizontal discrepancies exist. This is because in girls, the pubertal growth spurt comes and goes by quickly, thus making it possible to miss the optimal treatment time.[30]

Clinical perspectives that might be inferred from these findings include that although there is little justification for 2-phase treatment, starting 1-phase treatment earlier in high-angle girls might be advantageous owing to their smaller and shorter pubertal growth spurt. In addition, continuous vertical control of both upper incisors and lower molars, particularly in late treatment, might be indicated to help prevent opening of the MP and excessive incisal display. Clearly with treatment times of 38 months and 62 months for the 1-phase and 2-phase groups, respectively, these were difficult and prolonged cases to complete, requiring extensive use of headgear or functional appliances; the need for excellent patient cooperation should be stressed in the consultation, and other treatment alternatives, such as TADs or orthognathic surgery, should be considered.

CONCLUSIONS

- Severe Class II high-angle patients showed very similar anteroposterior and vertical skeletal as well as dental outcomes whether treated early with 2-phase therapy or later in 1 phase.
- There was a clinical tendency for patients in the late treatment group to have a higher posttreatment MP angle and more vertical extrusion of upper incisors and lower molars.
- There was a clinical tendency for female patients in the late treatment group to have a higher posttreatment ANB value, an increased FMA angle, and more upright upper incisors.

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