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Soft and Hard Tissue Changes after Presurgical Orthodontics in Class III Patients

I-Ming Tsai
Department of Craniofacial Orthodontics, Chang Gung Memorial Hospital, Taiwan; Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taiwan

Hui-Ling Chen
Department of Craniofacial Orthodontics, Chang Gung Memorial Hospital, Taiwan; Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taiwan

Yu-Ching Wang
Department of Craniofacial Orthodontics, Chang Gung Memorial Hospital, Taiwan; Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taiwan

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Abstract

The aims of this retrospective cephalometric study were to assess the results of presurgical treatment on the subjects presenting with Class III malocclusion and to evaluate the correlation between soft and hard tissues. Initial (T0) and presurgical (T1) lateral cephalograms of 17 patients were examined. Mean age was 20.4 years initially. Subjects were treated with presurgical orthodontic treatment. Initial and presurgical variables were compared using paired t-test, and the relationship of soft and hard tissue variables was studied using Pearson correlation coefficient and linear regression equation. Significant changes were found in hard (U1E 1.4±2.6 mm, FMIA -6.9±6.8°, IMPA 5.8±6.5°, L1E 2.4±2.4 mm) and soft tissue (Li 1.9±1.6 mm, Z-angle -5.0±7.3°). The increase of U1E was correlated with the increase in U1toSN angle and the ratio was 3.77. The increase of L1E was correlated with the increase in IMPA angle and Li, but decrease in Z-angle. The ratios were 3.04, 0.87, and -5.71, respectively. The ratios of soft to hard tissue movements derived from this study would contribute to the database for planning prediction.

Keywords

presurgical orthodontic treatment, dental decompensation, cephalometric analysis, soft tissue change

Research Report

Soft and Hard Tissue Changes after Presurgical Orthodontics in Class III Patients

I-Ming Tsai, Hui-Ling Chen, Yu-Ching Wang
Department of Craniofacial Orthodontics, Chang Gung Memorial Hospital, Taiwan
Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taiwan

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INTRODUCTION

Treatment of severe Class III malocclusion requires a combination of orthodontics and orthognathic surgery. In Class III patients, their upper incisors procline labially and lower incisors retrocline lingually. The upper molars tip buccally and lower molars tip lingually. They tend to occlude together despite the large skeletal discrepancy exists. The phenomenon is so-called dental compensation.

The goal of presurgical orthodontics is to position the teeth so that an optimal skeletal correction can be performed at surgery and dental arches can be compatible with the postsurgical and facial balance.[1,2] It typically retroclines the maxillary incisors and proclines the mandibular incisors to more normal inclinations. The teeth can be positioned ideally relatively to their apical bases. This "decompensation" increases the severity of

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Reprints and correspondence to: Dr. Yu-Ching Wang, Craniofacial Orthodontic Division, Dental Department, Chang Gung Memorial Hospital, Taoyuan, Taiwan No.5, Fusing St., Gueishan Township, Taoyuan County 333, Taiwan
Tel: 03-3281200 ext. 8322 Fax: 03-3281200 ext. 8376 E-mail: yuchingwng@gmail.com

the Class III dental malocclusion and often results in the patient's facial profile becoming more unesthetic before surgery.[3] The presurgical orthodontic decompensation of the dentition dictates the magnitude and type of surgical change and is a major factor in the success of treatment. Lack of optimal dental decompensation compromises the quality and quantity of the orthognathic surgical correction.[4]

Besides, studies have shown that if treatment directed only toward an occlusal result, the soft tissue changes may not provide the desired aesthetic result.[5] It has been observed that a great proportion of orthognathic cases treated in our centre involves bimaxillary surgery to correct skeletal Class III problems. However, little information is available on the soft and hard tissue changes resulting from presurgical orthodontics in this group of patients. The aims of this retrospective cephalometric study were to assess the results of presurgical treatment on the subjects presenting with Class III malocclusion and to evaluate the correlation between soft and hard tissues.

MATERIAL AND METHOD

Seventeen Taiwanese adults (9 men and 8 women; mean age, 20.4 years; range, 17 years to 28 years) seeking orthodontic treatment because of mandibular prognathism and Class III malocclusion participated in this study. Each was diagnosed as having a skeletal Class III relationship based on the ANB angle (mean, -4.9°; range, -1.2° to -10.0°) and their surgical designs were bimaxillary surgery. Means and ranges of several cephalometric variables are shown in Table 1. The subjects had good general and dental health, complete or nearly complete dentition and no history of temporomandibular joint disorders. The average duration of presurgical orthodontic treatment is 10.6 months. Lateral cephalometric radiograhs were obtained initially (T0) and presurgically (T1) to evaluate the equivalence of morphological characteristics.

One investigator made the landmark identifications and tracings. The tracings were digitized. These angles and distances were measured by using Image J (provided by NIH). The cephalograms were analyzed using a modified soft tissue analysis of Legan and Burstone[6] and Lew et al.[7](see Fig1.) The horizontal reference line (HP) was constructed by raising a line 7 degrees from sella-nasion, and a line perpendicular to HP at nasion was used as the vertical reference line. The hard and soft tissue landmarks were measured in millimeters to vertical reference line in the initial and presurgical cephalograms, and any differences in the distances were recorded as the presurgical changes.

STATISTICAL ANALYSIS

Descriptive statistics included the mean and standard deviation (SD). All statistical analyses were performed with a commercial statistical package (SPSS, version 10.0, Chicago, Il). Differences within patient were evaluated with paired t- test. The significance level was set at $p<.05$.

Pearson correlation analysis was used to screen the degree of correlation between soft and hard tissue changes. Soft-to-hard tissue movement ratios (S:H) and tooth movement-to-inclination change ratios were assessed by linear regression analysis.

To assess the error of localizing reference points and measurement procedure, 30 lateral cephalometric radiographs of 15 patients were retraced and re-measured by the same examiner four weeks later. No significant errors were found when the repeated measurements were compared to original data with paired t-test.

RESULT

The means and standard deviations for the skeletal and dental measurements are shown in Table 1, including significant differences before and after presurgical orthodontics. Significant changes were found in hard (FMIA -6.9±6.8°, IMPA 5.8±6.5°) and soft tissue (Z-angle -5.0±7.3°).

Horizontal changes of hard and soft tissue landmarks are listed in Table 2. There were significant differences in horizontal change of U1E (1.4±2.6 mm), L1E (2.4±2.4 mm), and Li (1.9±1.6mm) from T0 to T1.

Significant correlations and the ratios between the landmarks were presented in Table 3. The increase of U1E was correlated with the increase in U1toSN angle and the ratio was 3.77. The increase of L1E was correlated with the increase in IMPA angle and Li, but decrease in Z-angle. The ratios were 3.04, 0.87, and -5.71, respectively.

Table 1. *Mean values and differences of cephalometric measurements in the initial (T0) and presurgical (T1) stage.*

	T0		T1		T1-T0		
Variables	Mean	SD	Mean	SD	Difference	SD	P
SNA(°)	82.0	4.5	81.6	4.3	-0.4	2.1	0.443
SNB(°)	87.0	4.5	87.1	4.8	0.1	1.1	0.692
ANB(°)	-4.9	2.5	-5.4	2.6	-0.5	2.3	0.376
FMA(°)	28.0	5.7	28.7	6.1	0.8	3.0	0.304
FMIA(°)	72.7	9.1	65.8	10.3	-6.9	6.8	0.001*
IMPA(°)	80.4	7.0	86.3	9.0	5.8	6.5	0.002*
U1toSN(°)	114.9	6.2	116.8	7.5	1.9	7.3	0.295
Nasolabial angle(°)	85.4	12.1	86.0	9.9	0.6	6.7	0.708
Z angle(°)	82.4	11.9	77.4	8.7	-5.0	7.3	0.013*
OB(mm)	-0.4	2.5	-1.1	2.8	-0.7	2.3	0.209
OJ(mm)	-4.2	3.0	-5.2	3.7	-1.0	3.3	0.710
Upper lip depth(mm)	10.7	1.9	10.5	2.0	-0.2	0.8	0.447
Lower lip depth(mm)	4.1	3.2	4.1	1.6	0.0	2.7	0.986

* p<0.05

Table 2. *Horizontal changes of hard and soft tissue landmarks between the initial(T0) and presurgical(T1) stage.*

	T0		T1		T1-T0		
Variables	Mean	SD	Mean	SD	Difference	SD	P
ANS(mm)	2.9	3.3	2.9	2.9	0.0	0.8	0.815
A(mm)	-0.6	3.4	-0.5	3.1	0.1	0.9	0.791
U1E(mm)	7.6	4.7	9.1	4.6	1.4	2.6	0.041*
L1E(mm)	11.9	4.3	14.2	4.0	2.4	2.4	0.001*
B(mm)	7.5	5.2	7.9	5.2	0.4	1.3	0.206
Pg(mm)	9.8	6.1	10.1	6.2	0.4	1.5	0.309
Pn(mm)	29.2	3.6	29.4	3.3	0.1	0.7	0.428
Sn(mm)	15.4	3.9	15.8	3.7	0.3	1.0	0.196
Ls(mm)	22.0	4.4	22.4	4.4	0.5	1.6	0.254
Li(mm)	26.3	4.5	28.2	4.6	1.9	1.6	0.000*
Si(mm)	20.8	4.3	20.9	4.6	0.2	1.6	0.679
PgS(mm)	20.6	6.5	20.9	6.6	0.3	1.3	0.347

* p<0.05

Table 3. *Correlations and ratios between the changes of hard and soft tissues.*

		U1toSN (°)	Nasolabial angle (°)	Ls (mm)	Upper lip depth(mm)
U1E(mm)	r	0.745	-0.226	0.310	0.399
	p	0.001*	0.383	0.227	0.112
	ratio	3.77	-11.24	1.97	0.77

		U1toSN (°)	Nasolabial angle(°)	Ls(mm)	Upper lip depth(mm)
U1E(mm)	r	0.884	-0.526	0.737	0.369
	p	0.001*	0.030*	0.001*	0.145
	ratio	3.04	-5.71	0.87	2.97

Ratio: U1toSN, Nasolabial angle, Ls, or Upper lip depth/ U1E.
IMPA, Z-angle, Li, or Lower lip depth/ L1E.
**p<0.05*

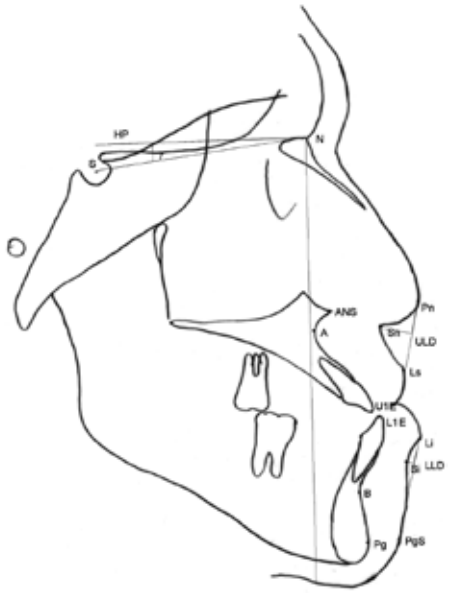

Fig 1. *Landmarks of soft, hard tissues and horizontal(HP) and vertical reference planes: ANS, anterior nasal spine; A, point A; U1E, maxillary incisor tip; L1E, mandibular incisor tip; B, point B; Pg, pogonion; Pn, pronasale; Sn, subnasale; Ls. labrale superius; Li, labrale inferius; Si, mentolabial sulcus; and PgS, soft tissue pogonion. ULD, upper lip depth; LLD, lower lip depth.*

DISCUSSION

Points A and B are commonly used as skeletal landmarks in cephalometric studies that investigate the efficacy of various treatment modalities on the sagittal relationship between the maxilla and mandible. Some authors have stated that point A and B are dentoalveolar landmarks that are influences by growth as well as dentoalveolar remodeling during orthodontic treatment.[8,9] However, in Al-Abdwani's study[10], they found that the magnitudes of changes in the skeletal landmarks were very small and irrelevant when they were considered alongside the other errors in cephalometric tracings. The effects of incisor inclination changes, due to orthodontic treatment, are of no clinical relevance to the position of point A and B, even though they may be statistically significant. It agreed with our result that the effect of orthodontic tooth movement didn't affect the horizontal position of points A and B.

It is important to note the relationship of surgical and orthodontic contributions to the best care of the patient. Orthodontic treatment planned without surgery generally will build more dental compensations for skeletal variations. However, orthodontic treatment planned in conjunction with surgery will remove dental compensations. Thus, surgical correction will not be limited due to the present dental compensation.[3]

Presurgical orthodontic treatment prepares the dentitions for the surgery. Different surgical design will alter the objectives of presurgical orthodontics. For our subjects in this study, because bimaxillary surgery combined with clockwise rotation of maxillomandibular complex (MMC),[11] including LeFort I osteotomy with or without multiple-segment osteotomy and bilateral sagittal split osteotomy, were planned, the upper and lower dentitions were prepared without extraction. So, the more proclined upper incisor inclination (from 114.9° to 116.8°) and more uprighted lower incisor inclination (from 80.4° to 86.3°) were builded after presurgical orthodontics. Although the upper incisors became more protrusive, clockwise rotation of MMC and multiple-segment osteotomy can contribute to correct proclined upper incisors.

Multiple-segment osteotomy is defined as an osteotomy that divides the tooth-bearing arch of the maxilla or mandible into three or more segments. Combining large-segment orthognathic surgery and small-segment surgery is an effective and safe approach for dealing with a wide range of dentofacial deformities with occlusal problems. It has been reported in our centre by Chen et al in 1999.[12] Their experience with 85 consecutive patients has shown that the results are good and the procedure is safe, with minimal complications. Thus, it's a popular surgical design in our centre until now.

Extraction of upper bilateral bicuspids and closing the extraction space for retraction of protrusive upper incisors before surgery are a typical method for dental decompensation.[3,13] Whether extraction increases the presurgical and total durations has been investigated before. Luther et al and Proffit et al[14] concluded the effect of extraction on duration of treatment is limited. Only the orthodontist's experiences appeared to affect the duration. On the contrary, Dowling et al found that orthdodontic treatment involving extractions increased the presurgical treatment time by 4.4 months and total treatment time by 3.7 months compared with nonextraction treatment.[15] Their mean presurgical duration for nonextraction was 14.5 months longer than ours (10.6 months). Although it is still a controversial issue, we regard using nonextraction to prepare the dentition for surgery may save the presurgical treatment time.[12]

Prediction of soft and hard tissue changes was studied before. Phonpraserth et al[16] found that the ratio of U1E to Ls was 1:1.7, and the ratio of L1E to Li was 1:0.9 after decompensation. The results were similar to ours (U1E to Ls was 1:1.97, and the ratio of L1E to Li was 1:0.87) although there was no significant correlation between U1E and Ls in our results.

Facial esthetics will be worsened as a sequence of presurgical orthodontics. The main reason is that dental decompensation increases the dental discrepancy, which results in more distance between upper and lower lips. In our study, the inceased distance is 1.4mm(Li-Ls) similar to Phonpraserth's study (1.9mm)[16] although we decompensate the lower incisors only.

However, it is interesting that the Z-angle tends to norms. The correlation between L1E and Z-angle is significant and the ratio is 1:-5.71. It means uprighting the retrusive lower incisors also contributes to normalize the Z-angle and balance the relationship of chin and lower lip.

The results of this study provide a reliable prediction of the changes of incisor inclination, tooth movement, and soft tissue. It will be easier to set the object of presurgical orthodontics according to the correlation between soft and hard tissue changes.

CONCLUSION

1. After presurgical orthodontic treatment, the sagittal (ANB) and dental (OJ) discrepancies were maintained in our subjects.
2. Presurgical orthodontic treatment uprights the retroclined lower incisors and increases the protrusion of lower lip.
3. IMPA, FMIA, Z-angle approximated to norms via decompensation of lower incisors.
4. The ratios of change are as follow:
   U1E: U1toSN= 1: 3.77
   L1E: IMPA: Li: Z-angle= 1: 3.04: 0.87: (-5.71)
5. The ratios of soft to hard tissue movements derived from this study would contribute to the database for planning prediction.

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安格列氏三級咬合在術前矯正後軟硬組織的變化

蔡一民．陳慧玲．王聿靖
林口長庚紀念醫院牙科部顱顏齒顎矯正科
長庚大學顱顏口腔醫學研究所

本研究的目的是以測顱X光片分析安格列氏三級咬合的病患在術前矯正治療後，其軟組織與硬組織的變化。有17位平均20.4歲，預計接受正顎手術的骨性第三級咬合病患，先施予手術前的矯正治療平均10.6個月。經由治療開始前及術前測顱X光片的比較得知：上顎門牙往唇側傾斜，下顎門牙向唇側傾斜，下嘴唇往外突出。相關性審查後並以線性回歸找出軟硬組織移動的比例，得到的結果可以提供臨床預測手術前的矯正治療後軟硬組織的相關變化。 ***(J. Taiwan Assoc. Orthod. 22(1): 21-27, 2010)***

關鍵詞：手術前矯正治療、牙齒去代償、側顱分析、軟組織變化

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聯絡及抽印本索取地址：林口長庚紀念醫院牙科部　桃園縣龜山鄉復興街5號　王聿靖
電話：03-3281200 轉 8322　傳真：03-3281200 轉 8376　電子信箱：yuchingwng@gmail.com