Evaluation of soft and hard tissue changes after bimaxillary surgery in class III orthognathic surgery

▪ Dr. Bassma Mustafa Gandila *

Abstract

Cephalometric study of 15 non-growing Class III subjects treated by bimaxillary surgery was undertaken to determine the changes in the position of nasal and labial soft tissues and hard tissue and to find a possible correlation between soft and hard tissue change. It was concluded that:

(i) The orthognathic profiles achieved by a combination of maxillary advancement and mandibular setback was enhanced

(ii) Strong to moderate correlation in the horizontal direction occurred between all the selected landmarks of the lower lip and chin, superior labial sulcus and point A in the upper lip and hard tissue movement

(iii) Vertical movement of landmarks on the nasal base, upper lip, chin and lower lip generally showed poor correlation with corresponding hard tissue points. The most reliable hard tissue predictors of horizontal and vertical soft tissue change are tabulated for application in bimaxillary surgery for the Class III patient

(iv) Our results revealed that the skeletal changes after bimaxillary surgery remained relatively stable for the period of study of (10 to12) month after the surgery.

■ ملخص:

تقييم التغيرات التي تحدث في الأنسجة الرخوة والصلبة بعد إجراء جراحة تقويمية للفكين العلوي والسفلي لمرضى يعانون من الأطباق من النوع الثالث

دراسة سيفالومتريه أجريت على سجلات تخص15 شخصا مكتملي النمو عولجوا بجراحة تقويمية للفكين العلوي والسفلي، وذلك لتعيين التغيرات في وضعيه الأنف والشفة العلوية والسفلية وايضا وضع الفكين العلوي والسفلي وايجاد أي علاقة محتمله بين هذه التغيرات.

Lecture Assistant In Orthodontic Department Faculty of Dentistry Tripoly University

سجلات المرضى الذين لديهم المعايير التالية ادخلوا في الدراسة:

1. مرضى أطباق من النوع الثالث لديهم دمج ما بين نقص في حجم الفك العلوي وزيادة في حجم الفك السفلى.
2. عولجوا بجراحة تقويمية شملت الفكين العلوى والسفلى.
3. لا وجود لأي جراجة اضافية ذات علاقة بموضوع البحث طيلة مدة الدراسة.
4. لا وجود لأى شق في الشفة او سقف الفم او أي متلازمة أخرى.
5. اشتراط وجود سجل كامل للمريض قبل وبعد الجراحة يتضمن الأشعة السيفالومترية الجانبية.

الأشعة السيفلومترية الجانبية جمعت عند:

ت 0: مبدئية (قبل بدء العلاج)

ت1: قبل الجراحة

ت2: بعد الجراحة (متوسط 3-1 شهور)

ت3: عند اكتمال العلاج (متوسط 10 - 12 شهراً)

وبالتحليل الإحصائي أظهرت النتائج ما يلى:

لا يوجد أي اختلاف ملحوظ بين كل الباراميترات المستخدمة في الدراسة ما بين ت0 وت1 وبذلك استخدمت ت1 فقط للمقارنة.

■ الاستنتاجات

1. تحسن المظهر العام للوجه بعد إجراء الجراحة التقويمية للفكين العلوي والسفلي
2. علاقة متوسطة إلى قوية في الاتجاه الأفقي ما بين حركة جميع النقاط الدالة على الأنسجة الرخوة وحركة الفكين العلوي والسفلي
3. علاقة ضعيفة في الاتجاه العلوي ما بين جميع النقاط الدالة على الأنسجة الرخوة والفكين العلوي والسفلى
4. كشفت نتائجنا بأنّ التغييرات الهيكلية بعد جراحة الفكين بقيت مستقرّة نسبيا في فترة الدراسة ما بين (10 إلى 12) شهراً بعد الجراحة.

•SUMMARY:

cephalometric study of 15 non-growing Class III subjects treated by bimaxillary surgery was undertaken to determine the changes in the position of nasal, labial soft tissues and hard tissue. And to find a possible correlation between soft and hard tissue change. It was concluded that:

(v) The orthognathic profiles achieved by a combination of maxillary advancement and mandibular setback was enhanced.

(vi) Strong to moderate correlation in the horizontal direction occurred

between all the selected landmarks of the lower lip and chin, superior labial sulcus and the upper lip and hard tissue movement

(vii) Vertical movement of landmarks on the nasal base, upper lip, chin and lower lip generally showed poor correlation with corresponding hard tissue points. The most reliable hard tissue predictors of horizontal and vertical soft tissue change are tabulated for application in bimaxillary surgery for the Class III patient.

(viii) Our results revealed that the skeletal changes after bimaxillary surgery remained relatively stable for the period of study of (10 to12) month after the surgery.

1) Introduction Due to the improvement in orthodontic and surgical techniques during the last two decades, a combined approach has been widely accepted as the preferred method to correct moderate to severe skeletal deformity. [Rustemeyer J, etal.2010; 14:155–162] (1). Found that the orthognathic surgery also allows orthodontists to solve the problems for which orthodontic treatment alone would do little to improve facial form. The recognition of aesthetic factors and the prediction of the final facial profile play an increasingly significant role in orthognathic treatment planning, since the facial profile produced by orthognathic treatment is of great significance for patients Many studies like[Chou JI,etal.2005; 63:355–361] (2). have attempted to evaluate the relationship between hard tissue surgery and its effect on the overlying soft tissue for predicting facial changes the most important goal for orthodontists and maxillofacial surgeons is to correct not only dental malocclusions but also to improve soft tissue profile after bimaxillary surgery. Facial soft tissue change that occur as a result of orthodontic treatment is a gradual alteration in facial features, while orthognathic surgery results in sudden and dramatic changes. It is therefore essential to be able to reliably predict postoperative soft tissue changes resulting from orthognathic surgery so that aesthetic results can be more accurately planned [Koh CH,etal. 1998; 20:25-33] (3).The study by [Enacar et al, 1999; 14:27–35] (4). suggested that the soft tissue responses to bimaxillary osteotomy were similar to those seen in mandibular setback surgery alone with exception of the changes in nasal tip projection and the upper-lip area

The aim of this study are:

1. To determine the changes in hard and soft tissue changes in skeletal Class III patients treated by orthognathic surgery involving bimaxillary osteotomies.
2. To find a possible correlation between the amounts of mandibular setback, maxillary advancement and their subsequent movement to the soft tissue

Material and method

This observational retrospective study was carried out on lateral cephalometric radiograph record of 15 subjects suffering of skeletal Class III deformities selected from a group of the orthognatic surgery treated patients. Patients who met the following criteria were included in the study:

1- Skeletal Class III cases showing a combination of maxillary deficiency and mandibular prognathism.

2- Surgical orthodontic treatment including bimaxillary surgery.

3- No other additional relevant surgery was performed during the duration of the study.

4- No cleft of lip or palate or other syndrome existed, and post-traumatic deformity were excluded.

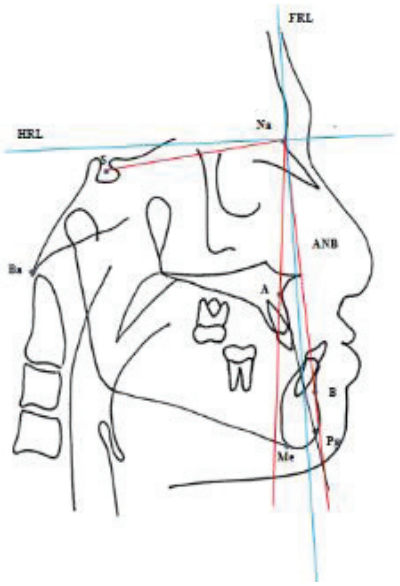
5- The presence of complete record before and after surgery including lateral cephalometric radiograph.

Sixty lateral cephalogram of fifteen patients with ranged age from 18 to 24 years were included in the study. Lateral cephalometric radiograph records were collected at: T0: before starting of treatment. T1: Before surgery T2: After surgery (1to3) month.T3: Post-treatment (when the treatment was completed), from10 to 12 months after surgery.

Lateral cephalometric radiographs were taken by a standardized technique with the jaws in centric occlusion, the lips relaxed, the head in the natural position, and the cephalostat in Frankfort horizontal plane. All radiographs were traced with a 0.35 mm graphite pencil on acetate paper. A record of lateral cephalograms was traced, starting with T0 and then tracings of the other cephalograms. The(T1,T2),(T2, T3) and (T1, T3) cephalograms were superimposed on sella (S), nasion (N), and anterior and posterior cranial base (figure1).

The following landmarks were identified:

- Sella (S): The midpoint of the cavity of the sellaturcica.
- Nasion(Na): The most anterior point of fronto-nasal suture.
- Basion(Ba): Midline point in anterior border of foramen magnum. Figure 1: (T1-T2) superimposition
- A Point: Deepest point of the curvature of frontal midsagittal section of the maxilla.
- Anterior nasal spine (ANS): Most anterior point in the maxilla.
- Posterior Nasal Spine (PNS): Most posterior point of the palate.
- B Point: Deepest point of the curvature of frontal midsagittal section of the mandible.
- Menton(Me):Most inferior point of symphysis of chin.
- Pogonion(Pg): Most anterior-inferior point of symphysis of chin.
- labral inferius(Li):the median point of the lower margin of the lower membranous lip



- labiomental sulcus (Si) :the point of greatest concavity in the midline of the lower

lip between Li and soft tissue pogonion

- Soft tissue pogonion (Pg'):the most prominent anterior

point of the chin in the midsagittal planeFigure 2: Reference lines used in the study

- Pronasale (pn):the most prominent anterior point of the nose
- Subnasale (Sn): the point at which columella margens with the upper lip in

the midsagittal plane

- Labral superius (Ls): appoint indicating the mucocutaneus border of the upper lip.

2) Skeletal changes: The following lines were used[Mankad B, etal1999; 14:19-26]. [5] :(figure2)

(HRL): The horizontal reference line was constructed by raising a line 7° from the sella-nasion line. (VRL): The vertical reference line was constructed perpendicular to the (HRL) at nasion.

The hard and soft tissue landmarks were measured to the horizontal and vertical reference line in the presurgical and postsurgical cephalograms.

Calculation of mandibular hard and soft tissue movements: The antroposterior mandibular movement was measured as a change in length of the line connecting the (Pg),(Me) (B) point, (Li), (Si) and soft (Pg`)to the vertical reference line. The vertical mandibular movement was measured as a change in length of the line connecting the (Pg), (Me) (B) point, (Li), (Si) and (Pg`) to the horizontal reference line.

Calculation of maxillary hard and soft tissue movements: The antroposterior movement of the maxilla was measured as a change in length of the line connecting the (ANS), (PNS) ,(A) point, (pn), (Sn) and (Ls) to the vertical reference line. The vertical movement of the maxilla was measured as a change in length of the line connecting the (ANS), (PNS), (A)point,(pn),(Sn) and (Ls) to the horizontal reference line.

All data was converted to actual size using known magnification for each radiograph.

- **Results**

Descriptive statistics were displayed as mean and standard deviation for the different measurements. Normality was checked using histograms and Wilks Shapiro test. Repeated measures analysis of variance with Huynh-Feldt correction was used (in case of violation of assumption of sphericity) to assess difference between mean measurements in different follow up periods (T0, T1, T2 andT3). Significant ANOVAs were followed by post hoc pairwise comparisons with Bonferroni adjustment. Changes in measurements between the follow up periods T2-T1, T3-T2 and T3-T1 were compared likewise using the same plan. Correlations between changes measurements of hard tissue movements were done using Pearson correlation coefficient. Relapse rate (%) was calculated as T3 - T2/T1 - T2 × 100.Changes in ANS-VRL, PNS-VRL and A-VRL were calculated to denote maxillary advancement whereas changes in B-VRL, Pg-VRL and Me-VRL were calculated to denote mandibular setback. Both were correlated with changes in soft tissue linear measurement. Correlation was referred to according the following ranges: strong correlation: ($r > 0.6$), moderate correlation: ($r = 0.3–0.6$), weak or no correlation: ($r < 0.3$).Significance level was set at the 5% level. Statistical

analysis was done using SPSS version 17.0. Line and bar charts were used for graphical presentation

Table (I): Comparisons of parameter indicating vertical maxillary and mandibular movement

	Mean (SD)								P value
	Before treatment T0		Before surgery T1		After surgery T2		Post treatment T3		
	mean	SD	mean	SD	mean	SD	Mean	SD	
ANS	56.72	5.67	58.25	3.72	57.90	5.06	58.83	4.19	0.166
PNS	53.78	4.21	54.29	3.12	54.87	3.69	55.17	3.11	0.327
A	69.15	11.63	68.10	2.89	69.90	3.85	69.96	3.85	0.982
B	112.60	10.84	112.52	7.04	109.07	5.70	111.02	4.81	0.165
Pg	129.82	9.78	132.31	6.64	130.52	6.40	132.27	6.19	0.344
Me	134.41	9.82	136.65	6.61	135.47	7.43	137.19	6.36	0.432

The maxillary and mandibular vertical measurements shown in table (I) reveled that there was no significant changes in the vertical maxillary and mandibular position among all treatment stages.

Also the vertical changes of soft tissue land mark shows no significant changes among all treatment stages

Table (II): Comparisons of parameter indicating antroposterior maxillary and mandibular position

	Mean (SD)								P value
	Before treatment T0		Before surgery T1		After surgery T2		Post treatment T3		
	mean	SD	mean	SD	mean	SD	mean	SD	
ANS	2.48a	4.18	1.50a	3.08	6.78b	4.12	5.46b	4.93	0.000
PNS	-37.52a	36.99	-48.92a	14.03	-41b	25.52	-51.15b	5.78	0.000
A	-2.07a	5.38	-3.02a	5.39	3.58b	5.29	1.50b	5.83	0.000
B	6.07a	7.42	4.96a	7.280	-0.33b	6.39	-0.73b	7.25	0.000
Pg	5.38a	8.3	4.52a	8.55	-0.65b	6.76	-0.81b	7.9	0.000
Me	-4.4a	8.77	-5.85a	9.24	-9.97b	7.91	-10.58b	7.79	0.000

Negative values indicate posterior position to vertical reference line.*: Statistically significant at p≤ 0.05

Table (II) it was found that: All parameters indicating antroposterior maxillary and mandibular position showed no statistically significant differences from T0 to T1 and fromT2 to T3.while It showed statistically significant differences from T1 to T2 and from T1to T3. At ANS the final measurement indicating maxillary anterior position at T3 was significantly larger with a mean of (5.46± 4.93) mm compared with its initial position at T1. While this parameter showed no significant change fromT2 to T3. At B point the final measurement indicating mandibular posterior position at T3 was significantly smaller with a mean of (0.73±7.25) mm compared with its initial position at T1. While this measurement showed no significant change fromT2 to T3

Table (III): comparisons of mean antroposteior maxillary and mandibular changes between treatment stages.

		Mean (SD)				Relapse rate
		(T2-T1)	(T3-T2)	(T3-T1)	P value	
		Surgical change	Post-surgical change	Overall change		
ANS	Mean	5.28a	-1.32b	3.96a	0.000	25%
	SD	2.43	2.37	2.88		
PNS	mean	7.92a	-10.15c	-2.231ac	0.021	128%
	SD	15.05	7.47	3.9		
A	mean	6.60a	-2.08b	4.52a	0.000	32%
	SD	3.3	3.84	2.25		
B	mean	-5.29a	-0.4b	-5.69a	0.035	-8%
	SD	5.26	5.35	7.07		
Pg	mean	-5.17a	-0.16b	-5.327a	0.038	-3%
	SD	5.46	5.94	7.49		
Me	mean	-4.12a	-0.61b	-4.731a	0.215	-15%
	SD	5.76	7.06	7.98		

The results of the paired *t* tests in table (III) showed the mean changes of antroposteior position of maxilla and mandible in the surgical change (T2-T1) the linear measurements showed a significant increase in value indicating maxillary anterior position. The mean of surgical forward movements for the

maxilla was (5.28± 2.43) mm measured at ANS and it showed significant decrease with a mean of(1.32± 2.73) mm in the posterior direction in the follow up period (T3 -T2).At the end of treatment the overall changes (T3-T1) showed no significant difference from surgical changes (T2-T1).

In the surgical change (T2- T1) the linear measurements showed a significant decrease in value indicating mandibular position. The mean of surgical movements for the mandible was (-5.29 ±5.26) mm in backward position measured at B point, whereas this measurement showed significant increase (-0.4 ±5.35) in forward position in the follow up period (T3 -T2). At the end of treatment the overall changes (T3-T1) showed no significant difference from surgical changes (T2-T1).figure3

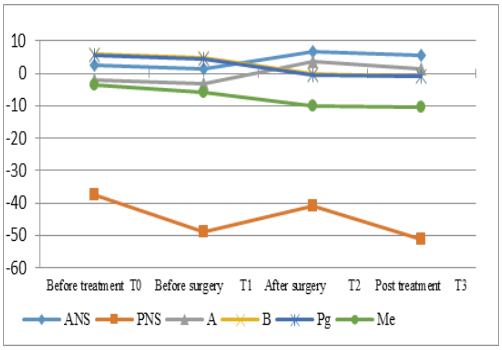


Figure (3): linear graph representing antroposterior maxillary and mandibular position.

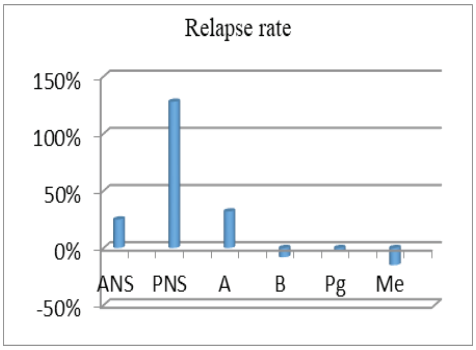


Figure (4): Relapse rate of maxillary mandibular antroposterior position

Relapse rate (%) of maxillary and mandibular antroposteriorposition was calculated as: Post- surgical changes (T3 - T2)/ surgical changes (T1 - T2) × 100 Figure (4)

Table (IV): Comparisons of parameter indicating antroposterior liner changes of soft tissue land marks

	Mean (SD)								P value
	Before treatment T0		Before surgery T1		After surgery T2		Post treatment T3		
	mean	SD	mean	SD	mean	SD	mean	SD	
Pn-VR	16.50a	3.73	16.00a	3.65	24.47b	4.17	23.57b	4.50	.000
Sn-VR	9.10a	2.74	9.13a	2.54	17.93b	3.28	17.43b	3.16	.000
Ls-VR	15.67a	2.64	15.67a	2.93	23.27b	3.45	22.50b	2.96	.000
Li-VR	19.40a	5.30	20.07a	5.29	10.27b	4.74	10.03b	3.93	.000
Pg-VR	19.60a	4.90	19.63a	4.99	9.87b	4.36	9.80b	4.85	.000
Si-VR	15.30a	5.13	15.37a	4.87	5.40b	5.90	6.03b	5.12	.000

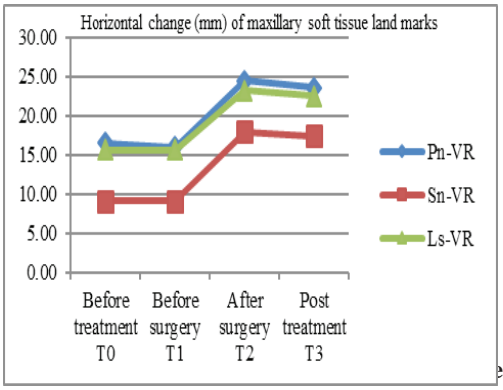
Table (IV) It was found that: All parameters indicating antroposterior maxillary and mandibular softe tissue position showed no statistically significant differences from T0 to T1 and fromT2 to T3.while It showed statistically significant differences from T1 to T2 and from T1to T3. At pn-VR the final measurement indicating nasal anterior position at T3 was significantly larger with a mean of (23,57± 4.5) mm compared with its initial position at T1.While this parameter showed no significant change fromT2 to T3. At pg-VR the final measurement indicating chin posterior position at T3 was significantly smaller with a mean of (9.8± 4.8) mm compared with its initial position at T1. While this parameter showed no significant change fromT2 to T3.

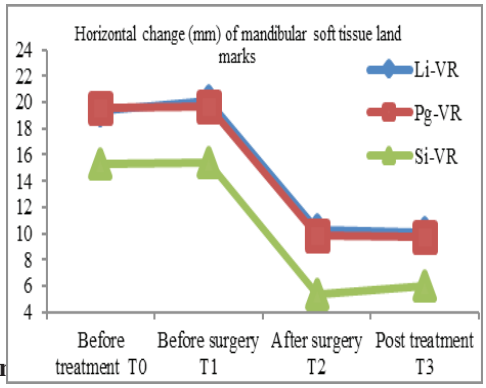
The results of the paired *t* tests in table (V) showed the mean changes of antroposteior position of soft tissue. In the surgical change (T2-T1) the linear measurements showed a significant increase in value indicating nasal anterior position. The mean of surgical forward movements for the nose was (8.47± 1.3) mm measured at pn-VR and it showed significant decrease with a mean of(0.9± 0.83) mm in the posterior direction in the follow up period (T3 -T2). At the end of treatment the overall changes (T3-T1) showed no significant difference from surgical changes (T2-T1). In surgical change (T2-T1) the linear measurements showed a significant decrease in value indicating chin posterior position. The mean of surgical backward movements for 5the chin was (9.77± 1.47) mm measured at pg-VR, and it showed significant increase with a mean of (0.07± 1.1) mm in the anterior direction, in the follow up period (T3 -T2). At the end of treatment the overall changes (T3-T1) showed no significant difference from surgical changes (T2-T1)

Table (V):Comparisons of mean antroposteior changes of soft tissue land marks between various treatment stages.

		(T2- T1)	(T3-T2)	(T3-T1)	P value	Relapse rate
		Surgical change	Post-surgical change	Overall change		
Pn-VR	Mean	8.47a	-0.90b	7.57a	.000	11%
	SD	1.3	0.83	1.32		
Sn-VR	Mean	8.80a	-0.50b	8.30a	.000	6%
	SD	1.85	0.57	1.71		

Ls-VR	Mean	7.60a	-0.77b	6.83a	.000	10%
	SD	1.62	1.05	1.25		
Li-VR	Mean	-9.80a	-0.23b	-10.03a	.000	-2%
	SD	1.7	1.13	2.21		
Pg-VR	Mean	-9.77a	-0.07b	-9.83a	.000	-1%
	SD	1.47	1.1	1.79		
Si-VR	Mean	-9.97a	0.63b	-9.33a	.000	6%
	SD	1.74	1.19	1.71		





	Mean (SD)								P value
	Before treatment T0		Before surgery T1		After surgery T2		Post treatment T3		
	mean	SD	mean	SD	mean	SD	mean	SD	
SNA	81.47a	5.9	80.54a	4.33	86.00b	4.31	84.12b	5.37	0.000
SNB	87.00a	5.08	86.77a	3.7	82.87b	3.5	82.08b	4.05	0.000
ANB	-5.53a	2.36	-6.23a	2.2	3.20b	2.04	2.04b	2.47	0.000
NAPg	-10.27a	6.61	-7.54a	10.53	7.20b	5.4	12.69b	30.4	0.001

The angular parameters (SNA, SNB, ANB, and NA-Pg) showed statistically significantly difference from T1 to T2, T2 to T3 and from T1 to T3, while from T0 toT1 showed no statistically significant difference

Table (VII) correlations between soft and hard tissue landmarks changes

			vertical		horizontal	
			T2-T1	T3-T1	T2-T1	T3-T1
Pn	ANS	Pearson Correlation	.191	.476	.667*	.689*
		p-value	.532	.139	.001	.000
Sn	ANS	Pearson Correlation	.175	.347	.593*	.471*
		p-value	.567	.296	.003	.004
Ls	A	Pearson Correlation	.526	.587	.446*	.563*
		p-value	.065	.058	.003	.002
Li	B	Pearson Correlation	-.157	.038	.767**	.563*
		p-value	.610	.912	.000	.000
Pg,	Pg	Pearson Correlation	.432	.445	.745**	.614*
		p-value	.140	.009	.001	.000
Si	Me	Pearson Correlation	.044	.097	-.705**	-.472*
		p-value	.886	.778	.000	.003

In table (VII) strong significant correlations between soft and hard tissue changes occurred cephalometrically in class III patients were found between pn ,Ans and sn,Ans in postoperative and post treatment corresponding landmarks in the horizontal plane also significance moderat correlations found between subnasale (ls) and point (A). Li whit point (B), Si whit Me and Pg′ whit pogonion (Pg) showed highly significant correlation in the horizontal plane representing a satisfactory accuracy for prediction.

No correlation between hard tissue and soft tissue measurements in vertical direction

• DISCUSSION

1) The Class III subjects selected for this study all presented a combination of maxillary retrognathism and mandibular prognathism confirmed by the presurgical mean values for SNA (81.47) and SNB (87.0) degrees, and hence the reason for the bimaxillary approach to surgery. In our study the post-surgical values showed that an orthognathic profile had been achieved by movement of both jaws antero-posteriorly,according to the presurgical ANB angle was (-5.53) Class III, postsurgical Class I was achieved by mean of(2.4) ANB angle assessed cephalometricaly. The superimposed on cephalogram T1 and cephalogram T2 groups confirmed the improvement in facial profile and approximate aesthetic

norms (Figure 1). Posterior movement of the mandible produced the backword change of the position of the anterior mandibular hard and soft tissue landmarks, had been carried out and so the maxillary movement. This may be ignored by clinicians, when they concentrate on hard changes, and this may influence the accuracy of profile prediction. Soft tissue response Horizontally, the results of this study are similar to historical reports of mandibular setback surgery stadied by[Hernández-Orsini R, 1989; 4: 209–218] (6) at pogonion and point B.

In this study any vertical movements of landmarks were mostly hard to predict. One reason might be that vertical movements, in our patients, were only minimal and beneath the capability of cephalometric analyses, since patients with massive vertical deficits were excluded to avoid any bias in this study. Accordingly,[Lin and Kerr1998; 20:25–33](7) also found in their cohort that these may account for the increased difficulty in accurately predicting a change in the vertical dimension. Further studies are warranted to evaluate the concept of vertical changes in patients with extensive vertical discrepancies

The vertical correlation coefficients of the soft to hard tissue movement are not present as those for horizontal change. Lin (1995) found that these may account for the increased difficulty in predicting change in this dimension accurately (8). The upper lip, superior labial sulcus, base of the nose moved with point (A),(Ans) anteriorly was cleared through the significant moderate correlation . Sub nasal is located at the junction of the soft and hard tissue over the maxilla and the nasal base. [Lines P A, etal 1974; 32: 891–896] (9).sated that Firm attachment to the base of the nose moving it horizontally in a proportional way with corresponding hard tissue movement This responses of the nasal base after surgery show correlation to the hard tissue changes in this study, which is similar to previous reports [Jensen A C, etal.1992; 101: 266–275](10).

Application of these soft tissue manipulating methods to maxillary advancement in Class III patients still needs further investigation to assess their effectiveness.In the lower lip and chin area the correlation was stronger. The data are arranged in Table VII indicating the soft and hard tissue points which relate well to one another in terms of response and which can be utilized in surgical planning and prediction. [Moss et al . 1988; 94: 469–475] (11). .have pointed out that the various types of operation and morphology of the anatomic structures must be considered in predicting the outcome of facial surgery .

Further investigations on other types of malocclusion and methods of surgical correction are essential to widen the database for planning prediction.

- **REFERENCE**

2) Jacobson A Psychological aspects of dentofacial esthetics and orthognathic surgery. Angle Orthod 1984;54:18–35

3) Kiyak HA, West RA, Hohl T, McNeill RW. The psychological impact of orthognathic surgery: a 9-month follow-up. Am J Orthod 1982; 81:404–412

4) Rustemeyer J, Eke Z, Bremerich. APerception of improvement after orthognathic surgery: the important variables affecting patient satisfaction. Oral Maxillofac Surg 2010; 14:155–162

5) Chou JI, Fong HJ, Kuang SH, Gi LY, Hwang FY, Lai YC, Chang RC, Kao SY.A retrospective analysis of the stability and relapse of soft and hard tissue change after bilateral sagittal split osteotomy for mandibular setback of 64 Taiwanese patients. J Oral Maxillofac Surg 2005; 63:355–361.

6) Enacar A, Taner T, Toroglu S .Analysis of soft tissue profile changes associated with mandibular setback and double-jaw surgeries. Int J Adult Orthod Orthognath Surg 1999; 14:27–35.

7) Koh CH, Chew MT. Predictability of soft tissue profile changes following bimaxillary surgery in skeleta1 class III Chinese patients. J Oral Maxillofac Surg 2004; 62:1505–15099.

8) Lin SS, Kerr WJS. Soft and hard tissue changes in Class III patients treated by bimaxillary surgery. Eur J Orthod. 1998; 20:25-33.

9) Lew KKK, Loh FC, Yeo JF, Loh SA. Evaluation of soft tissue profile following intraoral ramus osteotomy in Chinese adults with mandibular prognathism. Int J Adult Orthod Orthognath Surg. 1990; 5:189-97.

10) Mansour S, Burstone C, Legan H. An evaluation of soft tissue changes resulting from LeFort I maxillary surgery. Am J Orthod.1983; 84:37-47.

11) Mankad B, Cisneros GJ, Freeman K, Eisig SB. Prediction accuracy of soft tissue profile in orthognathic surgery. Int J Adult Orthod OrthognathSurg. 1999; 14:19-26.

12) Legan HL, Burstone CJ. Soft tissue cephalometric analysis for orthognathic surgery. J Oral Surg. 1980; 38:744-51.

13) Robinson S W, Speidel T M, Isaacson R J, Worms F W. Soft tissue profile change produced by reduction of mandibular prognathism. Angle Orthodontist 1972; 42: 227–235

14) Hernández-Orsini R, Jacobson A, Sarver D M, Bartolucci A.Short-term and long-term soft tissue profile changes after mandibular advancements using rigid fixation techniques. International Journal of Adult Orthodontics and Orthognathic Surgery 1989; 4: 209–218

15) Lin SS, Kerr WJ Soft and hard tissue changes in class III patients treated by bimaxillary surgery. Eur J Orthod 1998; 20:25–33

16) Lin S-S 1995 an assessment of accuracy of prediction of bimaxillary surgical correction of skeletal discrepancy. MSc Thesis, University of Glasgow

17) Lines P A, Steinhauser W W. Soft tissue changes in relationship to movement of hard structures in orthognathic surgery: a preliminary report. Journal of Oral Surgery 1974; 32: 891–896

18) Carlotti A E, Aschaffenburg P H, Schendel S A 1986 Facial changes associated with surgical advancement of the lip

19) Rosen H M Lip-nasal aesthetics following LeFort I osteotomy. Plastic and Reconstructive Surgery 1988; 81: 171–179

20) Jensen A C, Sinclair P M, Wolford L M Soft tissue changes associated with double jaw surgery. American Journal of Orthodontics and Dentofacial Orthopedics 1992; 101: 266–275

21) Moss J P, Grindrod S R, Linney A D, Arridge S R, James D A .computer system for the interactive planning and prediction of maxillofacial surgery. American Journal of Orthodontics and Dentofacial Orthopedics 1988; 94: 469–475