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REAPPRAISAL OF SOFT TISSUE PREDICTION IN ORTHOGNATHIC SURGERY FOR MANDIBULAR PROGNATHISM

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Cephalometric prediction tracing is the preoperative double checking procedure which can predict bony and soft tissue change.

Soft tissue profile prediction is routinely performed according to the known ratios of the soft to hard tissue movement which can vary considerably in each individual.

Besides interindividual variation of the ratios of the soft to hard tissue change, actual results of the postoperative soft tissue profile can reflect other important modifying factors if it is compared with prediction tracing used.

The purpose of this study is to compare soft tissue prediction tracing used with postoperative tracing and to find intervening modifying factor via serial tracing.

Review of 30 prediction tracing showed that the most important factor contributing to prodiction tracing inaccuracy was the skeletal and dental relapse. And, some factors which may be responsible for prediction tracing inaccuracy were discussed.

I. Introduction

Mandibular prognathism is a displeasing facial contour, furthermore can be a agonizing dentofacial deformity to each individual if untreated. During last two decades, there has been immense improvements in orthognathic surgery as a surgical treatment measure for dentofacial deformities.

As the more improved surgical methods has been devised to enhance the final surgical rsults, the need to predict the end result which embrace skeletal and soft tissue alteration has increased[1,2,3,4,5].

Most of two dimensional prediction techniques of the soft tissue are routinely performed immediately before operation and based on the patient's cephalogram, dental cast and previous retrospective stuidies as to soft tissue change following hard tissue change[1,2,5].

Accurate prediction of soft tissue profile closely related to hard tissue change is decidedly difficult problem because long term postoperative soft tissue profile if compared with predicted profile can be modified by many important variables throughout the total surgico-orthodontic treatment[6,7].

But, the study focused on the reliability of the prediction tracing and influcing factors to affect the final soft tissue profile compared with prediction tracing is relatively few.

The purpose of this study is to investigate the accuracy of prediction tracing in relation to final soft tissue profile and find the possible modifying factors influcing differences between prediction tracing and end results.

II. Materials and Methods

Thirty patients were randomly selected who had

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received orthognathic surgery due to mandibular prognathism at the department of oral and maxillofacial surgery, Seoul National University Hospital.

A criteria of selection was that the patient had been treated with mandibular surgical procedures only.

The materials used for this retrospective cephalometric study are prediction tracings for the surgical treatment planning and postoperative cephalograms which consist of immediate postoperative and 6 month follow-up cephalogram at least.

Basically, all cephalograms were made in the centric occlusion with the patient's lip in repose.

Prediction tehnique was based on the cephalometric prediction and cast prediction. All of the predictions were performed according to the known published soft and hard tissue ratio, which were done by the senior resident under the supervision of staff oral and maxillofacial surgeon.

The important skeletal and soft tissue landmarks were traced on the mattacetate sheet (immediate postoperative and at least 6 month follow-up cephalogram). This tracing was superimposed on the preoperative prediction tracing. The reference plane for superimposition was sella-nasion plane and basion was always used as a second reference point.(Fig. 1)

To assess the prediction tracing inaccuracy and find the contributing factor to prediction tracing inaccuracy, 2 stage cephalometric superimposition was done.

First, Class III skeletal patterns according to Sanborn's classification was also examined.

Second, P.T. inaccuracy without surgical deviation was examined with the superimposition of preoperative P.T. on 6 month follow-up tracing after we confirmed that the surgery was performed in accordance with surgical planning through the immediate postoperative cephalogram.

Third, prediction tracing (P.T.) inaccuracy due to surgical deviation from P.T. was mainly identified with the superimposition of preoperative P.T. on immediate follow-up tracing. Any differential between P.T. and postoperative results at any of the reference point which were smaller than 1 mm were not recorded.

All of the cephalometric landmarks used for this study was indicated on fugure 1.

All follow-up tracings and calculations were done manually only by authors.

Fouth, P.T. inaccuracy in relation to surgical set-back movement was examined. We classified mandibular set-back movements into 3 movements, the first, straight set-back movement along the occlusal plane the second, clockwise rotation and the third, counter-clockwise rotation movement.

Fifth, P.T. inaccuracy rate was investigated in relation to the stability of the jaw and dentition.

Total surgical procedures undertaken was summarized in Table 1.

Fig. 1: Cephalometric Landmarks

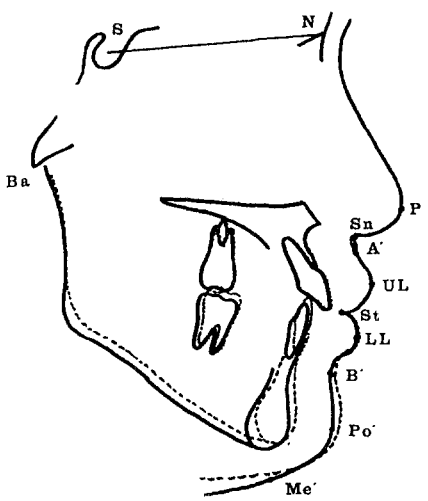

Table 1. Types of Surgery

Sex / Op.	Male	Female	Cases(%)
BSSRO*	8	15	23(76.7%)
BSSRO +Genio.*	1	2	3(10.0%)
VRO*	1	3	4(13.3%)
Total	10	20	30(100.0%)

BSSRO*; bilateral sagittal split ramus osteotomy
Genio.*; genioplasty
VRO*; extraoral vertical ramus osteotomy

III. Results

1. Skeletal patterns of Class III malocclusion (Figure 2 and Table 2)

As shown in figure 2 and table 2, about two thirds of the patients were placed in group A with the maxilla within the normal range and the mandible beyond the normal range. Group A was the most predominant skeletal patterns of Class III malocclusion.

Group C (both the maxilla and the mandible within the normal range) included 4 patient (13.3%).

Group B (the maxilla below the normal range and the mandible within the normal range), group D (the maxilla below the normal range and the mandible beyond the normal range) constituted 6.7% and 6.7% of the patients respectively.

2. Prediction tracing(P.T.) inaccuracy in relation to accuracy of the surgery(Table 3).

Fig. 2: Sanborn's classification

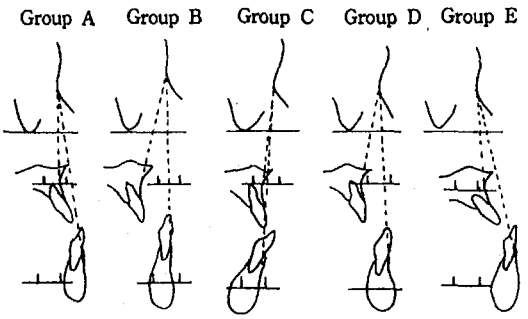

Table 2. Sanborn's classification of Class III skeletal patterns

Skeletal patterns	Cases	(%)
group A	19	63.3
group B	2	6.7
group C	4	13.3
group D	2	6.7
group E	3	10.0
Total	30	100.0

Table 3. Prediction tracing inaccuracy in relation to accuracy of the surgery

P.T. inaccurate group	Cases (%)
P.T. inaccuracy - accurate surgery	9(30.0)
P.T. inaccuracy partly due to surgery deviation from P.T.	6(20.0)
P.T. inaccuracy associated with surgery deviation from P.T.	4(13.3)
Total	19(63.3%)

Overall P.T. inaccuracy was observed in 19 cases (63.3%).

Of 19 cases, P.T. inaccuracy rate without deviation of surgery was 30.0% (9 cases). P.T. inaccuracy rate partially due to surgery deviation 20.0% (6 cases) and P.T. inaccuracy rate associated with surgery deviation from P.T. 13.3% (4 cases).

P.T. inaccuracy without deviation of surgery was the most frequent cause contributing P.T. inaccuracy.

3. Surgical subgroups by the types of surgical set-back movements of the mandible (Table 4)

Table 4. Types of surgical set-back movement of the mandible

Mandibular movement	Cases (%)
Counter-clockwise set-back	14(46.7%)
Straigth set-back	12(40.0%)
Clockwise set-back	4(13.3%)
Total	30(100.0%)

The counter-clockwise set-back movement of the mandible was showed in 14 cases (47.7%).

The straight set-back and clockwise movement of the mandible were 40.0% (12 cases) and 13.3% (4 cases) respectively.

Most of the mandibular movement were straight and counter-clockwise set-back movement in relation to occlusal plane.

4. Prediction accuracy in relation to surgical set-back movement of the mandible (Table 5)

Table 5. Accuracy rate in relation to set-back movement

Mandibular movement	Subtotal	Accurate group(%)
Clockwise set-back	4	2(50.0)
Counter clockwise set-back	14	5(35.7)
Straight set-back	12	4(33.3)
Total	30	11(37.7)

In clockwise set-back group, 2 cases of 4 cases (50.0%) showed prediction accuracy,

Counter-clockwise and straight set-back group showed 36.7% and 33.3% prediction accuracy rate respectively.

5. Positional stability of the jaw and dentition after operation in relation to P.T. accuracy

Only qualitative analysis of the skeletal and dental unstability was done. Horizontal and/or vertical positional change more than 1 mm was showed in 20 patients (66.6%).

The relationship of postoperative positional unstability to P.T. inaccuracy was summarized. (Table 6)

Table 6. P.T. inaccuracy in relation to positional unstability of jaw and dentition.

	P.T. inaccuracy group	P.T. accuracy group
Positional unstability group	14 cases	6 cases
Positional stability group	5 cases	5 cases
Subtotal (%)	19 cases (63.3)	11 cases (37.7)

14 cases out of total 20 positional unstability group (70.0%) showed P.T. inaccuracy in comparison with 5 cases out of 10 cases (50.0%) in positional stability group. But, there was no significant correlation between P.T. accuracy and positional stability of the jaw and dentition.

Ⅳ. DISCUSSION

This study was designed to verify the accuracy of prediction tracing used for orthognathic surgery retrospectively and identify the modifying factors influencing prediction tracing accuracy.

The cephalometric prediction is the doubling-checking procedure which consists of prediction of bony change and soft tissue change.

Besides above-mentioned important function, it can be a valuable medium for dialogue between patient and treatment team and evaluation of final treatment effects[7,8].

Several methods of soft tissue prediction have been suggested until now, which were basically 2 dimensional cephalometric study in combination with cast prediction. Recently, computer-aided methods for the planning of craniofacial and orthognathic surgery have been published[9,10].

These computer-aided methods have been based on cephalometric radiographs, computerized tomographic data or a combination of the two to provide graphic prediction of the surgical results.

The retrospective quantitative studies of the soft tissue change following various types of orthognathic surgery have been published by many authors[3,4,6,11,12,13,14,15,16], Some of these studies used multivariate regression analysis to predict the more correct postoperative soft tissue landmarks[17,18,19,20,21]

The procedure, superimposition of the cephalometric landmarks, produce unavoidable errors in the position of the same landmarks. Besides errors resulting from projective displacement and incorrect landmark identification, the third set of errors associated with the inaccuracy of the act of tracing superimposition itself have 2 basic gemometric factors, the first, rotational factor and the second, traslational factor.

For example, for a landmark which lies 10 mm away from the center of rotation, only 1 degree rotational error will produce 1.74 mm displacement in

the observed landmark position[22].

We randomly selected patients who received lower jaw surgery only. Of 30 patients, about two thirds of the patients had the group A skeletal pattern according to Sanborn's classification of skeletal pattern[15,28]. If the set-back movement of the mandible is beyond about 15 mm, intraoral surgical mandibular procedures have biologic limitations in its application[8].

We found significant inaccuracy of prediction tracing in 19 patients (63.3%) of all 30 patients. Any differential within 1 mm in landmark position was considered accurate to accomodate the tracing error[6,22].

Four of 19 case correspond to the deviation of surgery from initial treatment planning. This deviation of surgery can be grouped into 2 procedural factors, the first one, mismatched paper surgery to final jaw position and the second one, true surgical deviation of surgery from initial treatment plan. The first error can be identified on the immdeiate postoperative cephalogram and the second one, long-term follow up cephalogram respectively[6].

Recent introduction of rigid fixation method of the jaw fragments make it possible early release of intermaxillary fixation, early functional rehabilitation of mandibular movement and reduced relapse potential. But the effort to reduce the surgical deviation from initial treatment plan except exact matching of model surgery and paper surgery is pure surgico-orthodontic problem, this problem is beyond our discussion.

Nine patients out of total 19 inaccurate group showed minimal surgical deviation but prediction inaccuracy. The cause of this prediction inaccuracy without surgical deviation is a difficult problem to the clinician.

Although there are several published cephalometric norms by many clinicians for application to profile planning.

Each norm has its limitation[17].

Veriables to be considered as a possible modifying factors in soft tissue profile prediction for mandibular prognathism include skeletal and dental relapse, change of lip morphology and posture, soft to hard tissue inter relationship, deviation of surgical set-back movement, reliability of cephalometrics, comprehension of profile planning and so on[5,6,16,17,22,23].

Of these variables, relapse tendency during postoperative period was observed in 20 patients of total 30 patients (66.6%) irrespective of predication accuracy. From above data, postoperative unstability of the jaw and dentition can be a significant factor influencing soft tissue change[6,7]. The postoperative orthodontic treatment may be another important factors modifying the soft tissue porfile. Especially, overcorrection of the antrior teeth to counteract the postsurgical relapse and postoperative orthodontic teeth movement as pure treatment measure will influence the long-term change of soft tissue profile.

Therefore, to improve the accuracy of the prediction, a new evaluation for profile planning should be made immediately before surgery and adequate retention period prior to preoperative orthodontic teeth movement[7].

We investigated the type of the set-back movement of the mandible in relation to occlusal plane. Especially, counter-clockwise and clockwise movement of the mandible produce different amount of positional and directional change of cephalometric landmarks. Therefore, analysis solely based on skeletal and dental assessment must give way to incorperating soft tissue contour analsysis in diagnosis and treatment planning. And, we think that recent cephalometric prediction using stepwise mutiple regression analysis is the more predictable method to accommodate the different positional change of cephalometric landmarks in set-back movement of the mandible[5].

In profile planning of the facial soft tissue, the morphology and posture of the lip has several clinical implications in case of malocclusion.

According to the comprehensive study on the lip posture by Burstone[23], soft tissue changes following retraction of the incisor can more easily be predicted if the relaxed-lip position is used as a basis for such a prediction but, the technique obtaining a relaxed-lip position is reasonablly reproducible, but, like all muscular positions, somewhat variable.

Facial disharmony may be observed in the absence of dentoskeletal discrepancy. These facial disharmony may be associated with either inadequacies or redundancies of lip length[23].

We think that positional change of lip in relation to teeth and bony landmarks can have more significant correlation if lip morphology is to be estimated carefully.

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국문초록

외과적 악교절수술에 있어서 측모연조직예측의 재평가에 대한 연구

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정무혁 · 남일우

두부방사선사진을 이용한 안모의 측모예측은 악교정수술에 있어서 가장 중요한 수술전 치료계획의 한부분으로 술후 경조직과 연조직의 변화를 예상하며 술자와 환자간에 술후 결과를 의논하는 대화의 재료로서도 그 중요성이 크다.

그러나, 술후 환자의 최종적인 측모와 수술 직전에 수술 계획에 따라 시행한 술후 측모의 예측과는 차이가 있다. 이러한 수술 전 시행하는 측모 예측의 부정확성을 감소시키기 위하여 새로운 경조직 대 연조직 변화비율 등을 추정하는 많은 연구가 시행되어 왔으나 측모방사선 예측의 부정확도를 조사하고 이러한 부정확성에 영향을 미치는 변수를 확인함이 측모방사선예측의 부정확성을 이해하고 감소시키는 데에 있어서 그 중요성이 크다고 생각된다.

이에 저자들은, 이미 시행되어 수술에 사용된 술후 측모예측기록을 수술직후 두부방사선 사진 및 술후 최소 6개월 추적 방사선 사진에 중첩하여 측모 예측의 부정확도를 조사한 바 총 30명의 환자에서 20명(66.6%)이 부정확도를 보였고 악골 및 치열의 술후 위치 불안정성도 측모 예측 정확군과 부정확군에 모두 19명(63.3%)에서 발생하여 측모 예측의 부정확도 영향을 주는 중요한 요인으로 확인되었다.