Relationship between preoperative maxillomandibular transverse discrepancy and post-surgical stability in Class II malocclusion

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Relationship between preoperative maxillomandibular transverse discrepancy and post-surgical stability in Class II malocclusion

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ABSTRACT

Relationship between preoperative maxillomandibular transverse discrepancy and post-surgical stability in Class II malocclusion

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The aim of this study was to examine the relationship between the presurgical maxillomandibular transverse index and post-surgical stability one year after mandibular advancement. For the material and methods, twenty-two subjects who were treated with mandibular advancement were enrolled in this study. Postsurgical stability was defined as the horizontal mandibular position change of <2 mm in lateral cephalogram 1 year after surgery. Subjects were divided into two groups according to the maintenance of postsurgical stability: a stable (group S) and a less stable (group LS) group. Presurgical maxillomandibular transverse index was decided as Yonsei transverse index (YTI) one month before surgery. A logistic analysis was performed on the postsurgical stability according to the YTI value. The presurgical, post-expansion target YTI value was obtained using receiver operating characteristic (ROC) curve. There was no notable difference in the baseline characteristics of the two groups except for vertical positions of point A, B, and gender distribution. Before surgery, however, there was a significant difference in YTI at both fossa and CR level between the groups. The amount of mandibular advancement did not have a significant difference. The odds ratio for YTI was 0.35 (p = 0.024). Prediction of stability of presurgical YTI yielded an area under the ROC curve of 0.88. The cut-off value for YTI was 1.45 mm. This can be concluded that presurgical transverse index showed a correlation with postsurgical stability and correcting it in the presurgical phase to a certain level appears to aid securing postsurgical stability.

Key words: Bimaxillary surgery; Skeletal class II malocclusion; Mandibular advancement; Post-surgical stability; Transverse discrepancy; Maxillary expansion

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I. Introduction

Surgico-orthodontic therapy has become the standard procedure for correcting skeletal discrepancies between the maxilla and mandible.(Proffit and Fields, 2013) Recently, several studies also reported successful results for patients with severe Skeletal Class II malocclusion through the surgico-orthodontic procedure.(Conley and Legan, 2006; Eckmüller et al., 2022; Proffit et al., 2007) To achieve optimal outcomes for those patients, post-surgical stability is crucial, which depends on both patient's factors and operative technique.(Bailey et al., 2004) Additionally, establishing a sufficient occlusion before surgery was found to play an important role in maintaining stability after surgery.(Choi et al., 2016; Kim et al., 2014; Mah et al., 2017)

In most malocclusions accompanied with a severe skeletal deformity, the dentition may often be compensated to secure interdigitation.(da Silva Filho et al., 2008; Jacobs and Sinclair, 1983) Orthodontists employ various techniques to achieve presurgical decompensation in all three planes. Skeletal Class II relationships are often accompanied by underlying transverse discrepancies, and expansion of the maxillary arches were accomplished through presurgical orthodontics or an additional step of surgery.(Brandtner et al., 2015; Chamberland and Proffit, 2011; Sayin and Turkkahraman, 2004; Staley et al., 1985; Uysal et al., 2005)

With advancements in orthodontic methods, nonsurgical maxillary skeletal expansion procedures have emerged as effective means to address transverse deficiencies prior to the surgery.(Ahn et al., 2020; Lee et al., 2018; Lee et al., 2010) These advancements have alleviated the burden on patients who had to undergo another step of surgery, and also for orthodontists who had to deal with post-surgical relapse of expansion. Despite the increasing popularity of these techniques and the recognized importance of achieving sufficient occlusion before surgery for post-operative stability, there is a lack of research exploring the relationship between transverse deficiency and post-operative stability in Skeletal Class II malocclusion.

The purpose of this study was to analyze the skeletal stability 1 year after bimaxillary surgery of Class II malocclusion to examine the relationship between presurgical maxillomandibular transverse index and post-surgical stability. We hypothesized that the post-surgical position change of the mandible would differ depending on the maxillomandibular transverse differences before surgery.

II. Material and Methods

1. Study design/ sample

This study followed the guidelines of the Declaration of Helsinki and Our institutional review board approved this retrospective study and waived the requirement for patient-informed consent. The study sample was composed of subjects who presented skeletal Class II malocclusion and underwent mandibular advancement surgery with genioplasty from March 2005 through February 2022.

The inclusion criteria were as follows: age at surgery ≥ 18 years; diagnosed with skeletal Class II malocclusion with the ANB value greater than 4 degrees; requirement for conventional orthognathic bimaxillary surgery with presurgical orthodontic treatment (1-piece Le Fort I osteotomy and bilateral SSRO, genioplasty advancement); The exclusion criteria were as follows: Patients with syndromes, cleft lip of palate, previous history of orthognathic surgery, no record of maxillary arch expansion; significant menton deviation of > 4 mm from the facial midline; a known history of temporomandibular joint disease (for example, idiopathic condylar resorption) before surgery, the loss of or an incomplete series of identifiable lateral cephalometric radiographs or cone-beam computed tomography (CBCT) images.

Among skeletal Class II patients who had mandibular advancement surgery with genioplasty, 29 patients underwent “expansion”, “TPA”, “RPE” or “MARPE”. 3 patients were excluded due to lack of any CBCT records; 1 patient received surgery before comprehensive orthodontic treatment; 3 patients had a known history of fibromatosis, hemifacial microsomia or idiopathic condylar resorption. Eventually, 22 patients (8 Male and 14 Female) who fulfilled the inclusion criteria were enrolled in this study. (Figure 1)

Horizontal change at Infradentale in the lateral cephalograms 1 year after surgery was the primary predictor variable in this study. The study sample was divided into two groups according to the amount of Id change (T3-T2): group S including patients with changes within 2.0 mm, and group LS including patients with changes equal to or more than 2.0 mm.(Bailey et al., 2004)

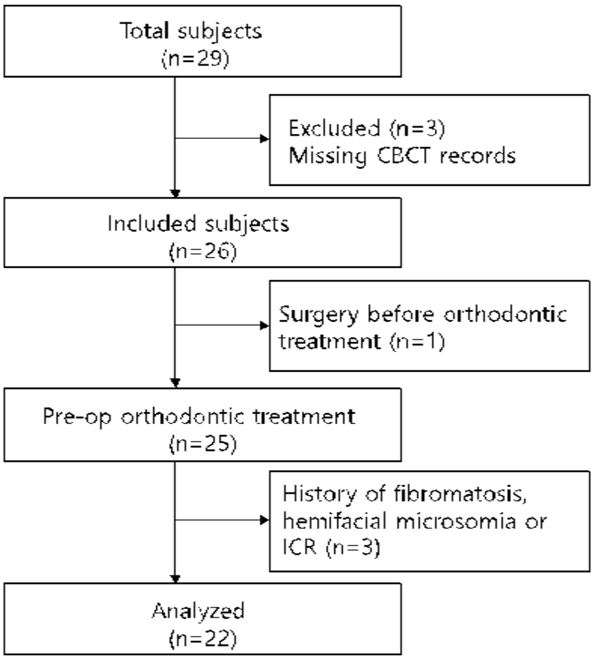


Figure 1. Flow chart of recruitment of subjects

2. Surgical and orthognathic treatment

Presurgical and postsurgical orthodontic treatment was performed in a single institution. Upper arches of the subjects were expanded via transpalatal arch (TPA), rapid palatal expander (RPE) or miniscrew-assisted RPE (MARPE). The expansion method was selected according to the amount of expansion required, molar inclination, periodontal biotype, age, gender, and clinical preference of the orthodontist. Presurgical orthodontic treatments including alignment, crowding relief, decompensation of tooth axes, and coordinating upper and lower arches, were performed for at least 6 months.

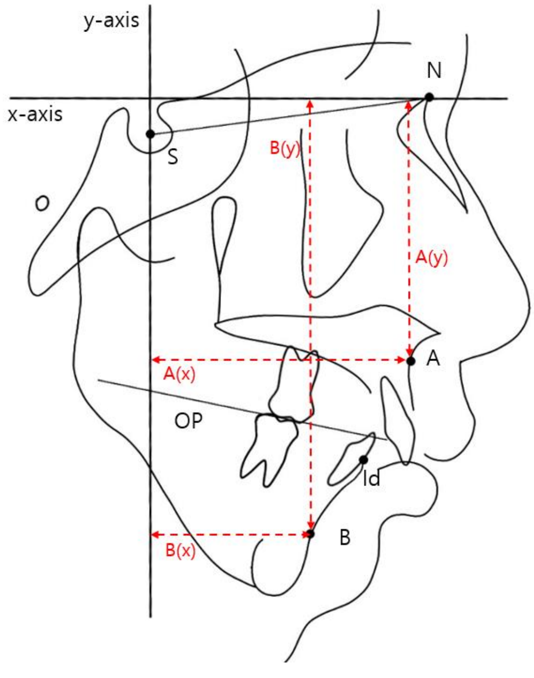
All patients went through conventional bimaxillary surgery, including Le-fort I osteotomy on the maxilla with posterior nasal spine impaction and bilateral sagittal split ramus osteotomy (SSRO) for mandibular advancement. Rigid internal fixation with self-reinforced biodegradable poly-70 L/30 DL-lactide (BioSorb FX; CONMED LINVATEC Biomaterials, Utica, NY) or titanium miniplates were used to stabilize the maxilla. After drilling and tapping, 4 L-shaped plates with mono-cortical screws (diameter, 2.0 mm) were placed in the canine fossa and zygomatic buttress bilaterally. Bilateral SSRO was carried out for mandibular advancement with concomitant genioplasty. Semi-rigid fixation with a titanium miniplate was used for the fixation of the proximal and distal segments. Post-operative orthodontic treatment was resumed after approximately 4 weeks.

3. Skeletal and dental evaluation

Cephalography of the following four phases of treatment were collected: initial (T0), within 1 month before surgery (T1), 1 month after surgery (T2), and 12 months after surgery (T3). For surgical examinations, CBCT imaging was performed on T1, T2 and T3. Surgical change was defined as T2 minus T1, and postoperative change was defined as T3 minus T2.

To investigate the relationship between presurgical transverse index and post-surgical stability, Yonsei transverse index (YTI) from CBCT at T1 was chosen for representing the transverse discrepancy at preoperative phase. Post-surgical stability was defined as changes less than 2mm with respect to the horizontal position change of Infradentale between T2 and T3.

The specifics of the measurements are as follows. The lateral cephalograms were digitized using V-ceph 5.5 (Osstem, Seoul, Korea). A line through Nasion, rotated 7° from the Sella-Nasion line, was used as the horizontal reference line (x-axis). This line approximated the Frankfort horizontal plane. The y-axis was perpendicular to the x-axis and passed through Sella (Figure 2). Id was applied to determine mandibular position, as this point would be less affected by surgery.(Baik et



al., 2021) [18]

Figure 2. Skeletal landmarks used in cephalometric analysis . S, sella; N, nasion; A, point A; B, point B; Id, Infradentale; OP, occlusal plane; SN-OP, angle of the sella-nasion plane to the

occlusal plane; x-axis, defined by the origin at N and forming a 7 degree angle upward from the SN plane; y-axis, defined as the line perpendicular to the x-axis and passing through S; A(x), horizontal position of point A; A(y), vertical position of point A; B(x), horizontal position of point B; B(y), vertical position of point B.

CBCT examinations (Alphard, version 3030; ASAHI Roentgen IND, Kyoto, Japan) were conducted by scanning of the maxillofacial regions (10 mA, 80 kV; 0.39-mm voxel size; scan time, 17 seconds; and a field view of no more than 200 mm in height X 200 mm in depth). Images were then reoriented as parallel to the palatal plane (sagittal section), passing through the furcation of the maxillary first molars (axial section), and parallel to the hard palate (coronal section). Measurements took place in axial slices, and width was defined as the distance between one furcation point and the vertical projection of the other furcation when observed from the coronal slice at the first molar plane.

This study identified 4 angular and 6 linear cephalometric measurements along with 4 linear measurements from CBCT images. The 4 angular measurements included the angle between the lines connecting S, N, and point A (SNA); the angle between lines connecting S, N, and point B (SNB); the angle between the SN and occlusal planes (SN-OP); the angle between the SN and mandibular planes (SN-MP). The 6 linear measurements included horizontal distances from point A, point B, the Id; and vertical distances from point A, point B, and Id.

Based on the previous findings, the estimated centers of resistance (CR) points were located at the middle of the root furcation of the first permanent molars.(Koo et al., 2017; Lee et al., 2018; Smith and Burstone, 1984) 4 linear measurements from CBCT images included the inter-central fossa and inter-CR widths at the first molars of the upper and lower arches. Yonsei transverse analysis was applied for transverse measurements.(Koo et al., 2017) Yonsei transverse index (YTI) at T1 was chosen for representing the transverse discrepancy at preoperative phase, to investigate the relationship with post-surgical stability. (Figures 2 and 3) All cephalograms and CBCT images were traced by the same examiner.

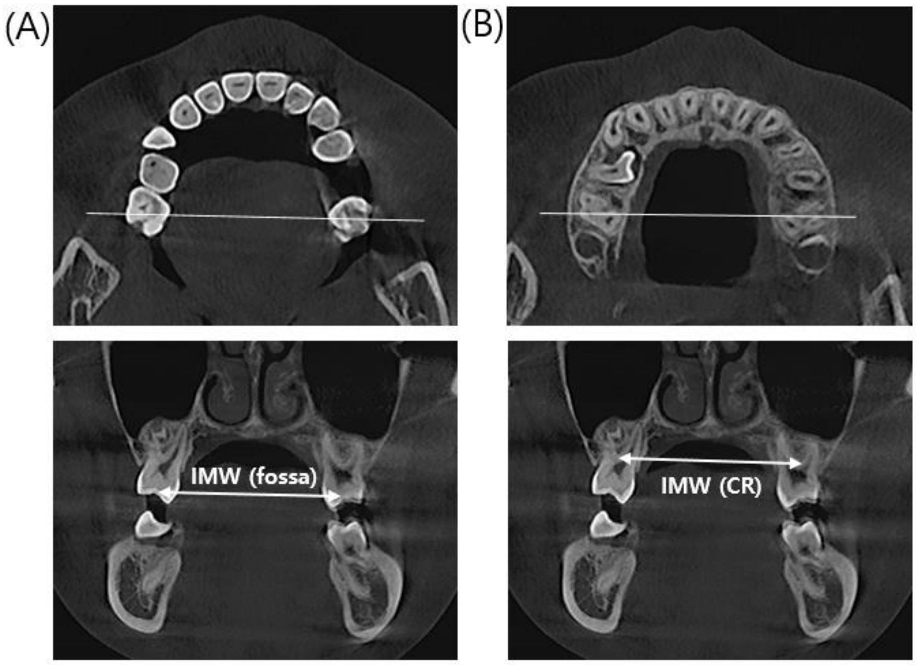


Figure 3. Measurements used in CBCT images (A)IMW at central fossa. (B)IMW at CR**.** IMW, intermolar width; CR, center of resistance

4. Statistical analysis

Statistical analyses were carried out using SPSS software for Windows (version 26.0; SPSS Inc., Seoul, Korea).

Based on the YTI values from our preliminary study and utilizing G*Power 3.1 (Dusseldorf, Germany), the required sample size was calculated to be more than 13, with a type II error rate (β) of 0.2, a significance level (α) of 0.05. Descriptive statistics, including the mean and the standard deviation, were used to describe the distribution of each variable.

For analysis of the method errors, all the linear and angular measurements of 30% subjects, randomly selected, were repeated by the same investigator on 2 separate occasions at least 2 weeks apart to evaluate the intra-examiner reliability.

Shapiro-Wilk test was used to verify the normality. Independent T-tests and Mann-Whitney *U* tests were used to compare the numerical values between group S and LS. Fisher's exact tests were used to compare categorical variables.

Univariate logistic regression was performed for the values that had significant differences between the groups. Subsequently, if $p < 0.05$ after the regression, the variable was chosen for candidate for multiple logistic regression. Regarding the target transverse index, the optimal cut-off value was determined using receiver operating characteristic (ROC) curve analysis to predict stability. Area under ROC (AUROC) was used to assess the predictive performance.

III. Results

Cephalometric variables describing presurgical cranial and dentofacial morphology of the subjects are summarized in Table 1. Group S included 13 patients with mean ΔId(x) of -1.6 mm, and group LS included 9 patients with mean ΔId(x) of -0.6 mm. There was no significant difference between groups in age and horizontal measurements. However, a significant difference existed in gender distribution.

Table 1. Patient's baseline values

Demographic variables	Group S (*n* = 13)	Group LS (*n* = 9)	*p*-value
Sex, *n* (%)			0.043*
Men	2 (15.4)	6 (66.7)	
Women (%)	11 (84.6)	3 (33.3)	
Age (yr), mean ± SD (range)	25 ± 3.7	25.7 ± 5.1	0.130
Lower premolar extraction	12/13	7/9	
Cephalometric variables, mean ± SD			
Angular measurements (°)			
ANB	8.3 ± 3.1	8.4 ± 3.7	0.956
SN-OP	27.1 ± 6.6	25.8 ± 4.2	0.570
SN-MP	49.4 ± 7.6	49.7 ± 6.5	0.934

Linear measurements (mm)			
A (x)	61.5 ± 3.9	61.5 ± 3.4	0.977
B (x)	37.0 ± 7.3	37.0 ± 7.3	0.994
A (y)	66.1 ± 3.3	70.6 ± 5.8	0.021
B (y)	113.3 ± 7.2	122.8 ± 11.7	0.028
Id (x)	51.3 ± 4.8	51.3 ± 5.2	0.99
Id (y)	99.4 ± 6.9	105.7 ± 9.1	0.077

Abbreviations: SNA, angle of the lines connecting the sella, nasion, and point A; SNB, angle of the lines connecting the sella, nasion, and point B; SN-OP, angle of the sella-nasion plane to the occlusal plane; SN-MP, angle of the sella-nasion plane to the mandibular plane; A(x), horizontal position of point A; B(x), horizontal position of point B; A(y), vertical position of point A; B(y), vertical position of point B; Id(x), horizontal position of Infradentale; Id(y), vertical position of Infradentale; $*p < 0.05$

1. Pre-surgical observations

At T1, most of the measurements of point A, and Id were similar between the two groups (Tables 2 and 3). However, the LS group showed significantly lower vertical height at B(y) (p = 0.012).

Intermolar widths (central fossa, CR) in the upper arch, and lower IMW at central fossa did not have a significant difference between the two groups. On the other hand, lower IMW at CR (p = 0.017), and YTIs (central fossa, CR) had a significant difference (p = 0.012 and 0.001), indicating a difference in transverse decompensation. (Table 4)

2. Surgical change

One month after surgery, there was no significant difference in the horizontal position of the maxillae between the groups. In the vertical plane, point A in group S was superiorly positioned than group LS. (Table 3)

The amount of mandibular advancement in both groups did not have a significant difference. Advancement in group S was 4.1mm for point Id, whereas advancement in group LS was 3.1 mm for point Id. The amount of vertical correction also did not differ. Anterior movement of the mandible was accompanied by a significant increase in SNB of 2.8 ° (group S) and 2.4 ° (group LS). (Table 2)

Intermolar widths measured from the central fossa and CR level in the upper and lower arch (IMW Mx crown, IMW Mx CR, IMW Mn crown, IMW Mn CR) did not have a significant difference between the two groups. Hence, YTIs (central fossa, CR) had a significant difference (p = 0.026 and 0.014). (Table 4)

Table 2. Descriptive statistics of the angular measurements according to the predictor variable (group) at different time periods

Outcome variable (°)		T1	T2	T3
ANB	Group S	8.3 ± 3.4	4.7 ± 3.5	4.7 ± 3.2
	Group LS	8.1 ± 3.1	5.7 ± 3.4	5.5 ± 2.8
	p-value	0.865	0.53	0.541
SN-OP	Group S	28.0 ± 5.9	27.1 ± 6.6	26.5 ± 6.7
	Group LS	27.7 ± 3.9	25.9 ± 4.6	26.9 ± 4.7
	p-value	0.873	0.645	0.882
SN-MP	Group S	48.5 ± 8.0	44.9 ± 5.9	45.4 ± 5.8
	Group LS	49.5 ± 5.7	47.0 ± 6.3	47.7 ± 5.7
	p-value	0.754	0.422	0.352

Abbreviations: ANB, angle of the lines connecting the point A, nasion, and point B; SN-OP, angle of the sella-nasion plane to the occlusal plane; SN-MP, angle of the sella-nasion plane to the mandibular plane; T1, 1 month before surgery; T2, 1 month after surgery; T3, 1 year after surgery

*$p < 0.05$

Table 3. Descriptive statistics of the linear measurements according to the predictor variable (group) at different time periods

Outcome variable (°)		T1	T2	T3
A(x)	Group S	61.8 ± 4.1	60.8 ± 4.6	60.7 ± 4.3
	Group LS	61.7 ± 3.4	61.1 ± 4.1	60.9 ± 3.9
	p-value	0.985	0.888	0.924
B(x)	Group S	38.2 ± 9.1	43.6 ± 8.9	43.3 ± 8.8
	Group LS	37.3 ± 6.8	41.3 ± 8.1	41.5 ± 8.0
	p-value	0.806	0.537	0.633
A(y)	Group S	66.5 ± 2.9	63.7 ± 4.5	63.6 ± 4.2
	Group LS	70.5 ± 5.7	68.1 ± 5.1	67.5 ± 5.5
	p-value	0.072	0.047*	0.071
B(y)	Group S	113.9 ± 7.2	113.3 ± 6.7	113.8 ± 7.1
	Group LS	124.4 ± 10.7	122.2 ± 8.7	118.9 ± 10.2
	p-value	0.012*	0.013*	0.177
Id(x)	Group S	49.3 ± 5.0	53.4 ± 7.0	52.8 ± 6.7
	Group LS	50.7 ± 4.7	53.8 ± 5.5	52.8 ± 6.7
	p-value	0.529	0.887	0.83
Id(y)	Group S	99.6 ± 6.0	99.2 ± 5.2	98.8 ± 5.1
	Group LS	106.0 ± 9.2	103.2 ± 7.5	98.8 ± 5.1
	p-value	0.059	0.158	0.172

Abbreviations: A(x), horizontal position of point A; B(x), horizontal position of point B; A(y), vertical position of point A; B(y), vertical position of point B; Id(x), horizontal position of Infradentale; Id(y), vertical position of Infradentale.

*$p < 0.05$

Table 4. Descriptive statistics of the transverse measurements according to the predictor variable (group) at different time periods

		T1	T2	T3
IMW Mx crown	Group S	46.5 ± 2.8	46.7 ± 2.9	45.5 ± 2.6
	Group LS	45.0 ± 3.9	45.3 ± 3.2	45.3 ± 3.2
	p-value	0.295	0.298	0.874
IMW Mx CR	Group S	45.7 ± 2.6	45.5 ± 2.9	45.1 ± 2.9
	Group LS	45.0 ± 3.3	44.1 ± 3.7	44.6 ± 3.3
	p-value	0.578	0.307	0.686
IMW Mn crown	Group S	40.2 ± 2.4	40.5 ± 2.2	39.8 ± 2.3
	Group LS	41.3 ± 3.3	41.7 ± 3.4	41.0 ± 3.1
	p-value	0.382	0.32	0.307
IMW Mn CR	Group S	42.1 ± 2.3	43.0 ± 2.3	42.7 ± 2.4
	Group LS	45.0 ± 2.8	44.9 ± 2.8	44.0 ± 3.1
	p-value	0.017 *	0.181	0.307
YTI crown	Group S	6.3 ± 2.9	6.2 ± 2.9	5.7 ± 2.2
	Group LS	3.7 ± 1.4	3.6 ± 1.6	4.3 ± 1.7
	p-value	0.012 *	0.026 *	0.122
YTI CR	Group S	3.6 ± 2.2	2.5 ± 3.2	2.4 ± 3.0
	Group LS	0.0 ± 1.9	-0.8 ± 2.2	0.6 ± 2.0
	p-value	0.001 *	0.014 *	0.136

Abbreviations: IMW Mx crown, intermolar width(IMW) of the maxillary arch at the central fossa; IMW Mx CR, IMW of the maxillary arch at the furcation; IMW Mn crown, IMW of the mandibular arch at the central fossa; IMW Mn CR, IMW of the mandibular arch at the furcation; YTI crown, YTI at the central fossa; YTI CR, YTI at the furcation

*$p < 0.05$

3. 12 months after surgery

Twelve months after surgery, in group S, point A had moved 0.1 mm posteriorly and 0.1 mm upward. In group LS, point A moved 0.2 mm posteriorly and 0.6 mm upward, and there was no significant difference in the horizontal and vertical position of the maxillae between the two groups. (Table 3)

The mandible moved 1.2 mm backward regarding point Id and 0.2 mm backward in point B in group S. In contrast, the mandible moved 2.7 mm backward in point Id and 0.3 mm forward when measured in point B in group LS. The post-surgical horizontal changes (T2 to T3) measured from point Id and vertical changes measured in point B were significantly different between the two groups. (p = 0.009 and 0.03) However, there was no significant difference between the horizontal and vertical mandibular position of the two groups at T3. (Tables 3)

ANB remained stable over the twelve months after surgery for both groups, when there was a significant difference in the relapse of occlusal plane angle (Table 2). The SN-OP angle decreased by 0.6 ° in group S, when it increased by 1.0 ° in group LS. The SN-OP at T3 in the two groups, however, did not show a difference.

Both YTIs obtained from the crown and center of resistance, and intermolar widths did not show a difference at T3. However, there was a significant difference in the postoperative post-expansion change of intermolar widths between the two groups. IMW Mx crown decreased by 1.1 mm and IMW Mx CR decreased by 0.4 mm in group S, whereas IMW Mx crown increased by 0.1 mm and IMW Mx CR increased by 0.5 mm in group LS (Table 4)

4. Prediction of stability

Prediction of stability based on YTI CR yielded an area under the ROC (AUROC) of 0.88. A selected cut-off with the highest Youden index value on the ROC curve was YTI CR at 1.45 mm with sensitivity of 0.888 and specificity of 0.846, suggesting good predictive accuracy at this threshold as illustrated in Figure 4.

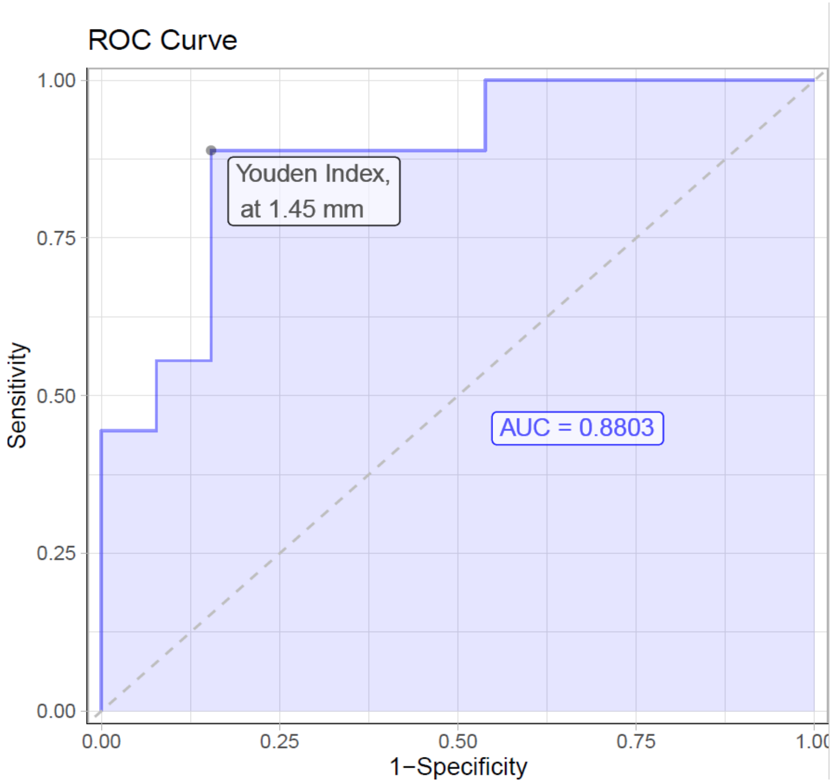


Figure 4. Receiver operating characteristic (ROC) curve

Multiple logistic regression analysis was run with group as the criteria and preoperative YTI and gender as predictors. The odds ratio for YTI was 0.35 (p = 0.024, CI:0.14, 0.87), indicating a decrease in odds with increasing YTI CR. However, gender did not emerge as a statistically significant factor, highlighting that YTI CR is a more pivotal determinant in the model used for predicting post-surgical stability.

IV. Discussion

The primary finding of our research is that post-orthodontic pre-operative transverse index is associated with greater than 2 mm horizontal position changes at point Id, 1 year after 2-jaw surgery for Class II patients, which implicates the effect of transverse discrepancy on postoperative stability. Additionally, prediction of stability based YTI CR yielded AUROC of 0.88, which is considerably high.

Addressing transverse discrepancies is a fundamental goal of orthodontic treatment and may be relevant to achieving post-treatment occlusal stability.(Koo et al., 2017; Mobarak et al., 2001) However, occlusal stability does not necessarily translate to post-surgical stability. This study's results indicate that YTI is correlated with post-surgical stability, suggesting that adequate occlusal alignment may influence surgical outcomes. While sagittal discrepancies have been known to affect post-surgical stability, to the best of our knowledge, this study is the first to uncover the impact of transverse discrepancies.(Proffit et al., 2007)

The average post-surgical change of the subjects was less than 2 mm, possibly disguising the troublesome cases. As Bailey et al. addressed, there are a certain portion of problematic cases and statistics based on normal distribution to describe post-surgical responses may be misleading.(Bailey et al., 2004) Proffit et al. reported that skeletal position change greater than 2 mm after surgery is clinically significant.(Bailey et al., 2004; Proffit et al., 2007) Therefore, our sample was divided into two groups with and without clinically significant changes. Among 22 patients, 9 experienced horizontal mandibular changes greater than 2 mm. Posterior mandibular displacement, in other words, relapse was observed in 7 (31.8%) patients. This result is in accordance with previous findings on the incidence of relapse after mandibular advancement for

Class II / high angle patients.(Joss and Vassalli, 2009; Mobarak et al., 2001)

The risk of post-surgical instability is known to be associated with diverse factors, such as operative procedure, extent and direction of relocation, fixation, age and growth potential, orthodontic recurrence and unsecured occlusion.(Eckmüller et al., 2022) Of all potential factors, preoperative mandibular plane angle and fixation methods were commonly reported to be associated with relapse.(Gaitan-Romero et al., 2021; Joss and Vassalli, 2009; Mobarak et al., 2001) In our cohort, such factors were homogenous between the groups except gender and preoperative YTI, subsequently leading to further investigation of prediction based on this index. Considering surgical results of men were thought to be more stable than women postoperatively,(Chen et al., 2020) YTI may have more association with stability considering the confounding effects.

Zhang et al. reported that YTI provided superiority over other transverse values regarding reliability,(Zhang et al., 2023; Zhang et al., 2021) which aligns with the high reliability of measurements in this study. It should be noted that YTI was initially introduced in the measurement of transverse discrepancy of non-extracted dentures, however, this study was comprised in which all but three were extracted. This dominance of lower premolar extraction might have contributed to the larger YTI value than other literature (-0.39 ± 1.87 mm).(Koo et al., 2017; Lee et al., 2018) Since there was no significant difference of YTI between the groups taking into consideration the extraction cases and also the proportion of extracted dentures, we inferred the investigation to be valid. This application of YTI to extracted dentures may expand the usage of this index in the future.

Transverse issues can be associated with anteroposterior problems.(Chung et al., 2001; Gunyuz

Toklu et al., 2015) Inadequate transverse occlusion can possibly affect incisal relationship.(Lee et al., 2018) Surgery cases would not be an exception. In this study, a subject with a greater YTI value tended to have better post-surgical stability. A possible explanation for this is that an adequate transverse occlusion could yield a more stable mandibular position shortly after surgery.

Using the maxillomandibular transverse index (YTI), the prediction of post-surgical stability was evaluated through the area under the ROC curve, which demonstrated excellent performance.(Hosmer et al., 2013) For the practical clinical application of YTI, a cutoff value of 1.45 mm was established, corresponding to the maximum Youden index. This cutoff value proved to be effective when predicting stability. A 1.45 mm measurement may serve as a benchmark for preoperative transverse correction. The less stable group (group LS) yielded a preoperative YTI ranging from -3 to 1.4 mm, which is closer to the known value of the YTI in normal, class I subjects.(Koo et al., 2017) We can assume that there are a lot of aspects that contribute to the post-surgical stability such as occlusal force, muscle adaptation and so forth. Additionally, the approach of using the AUROC curve in this study could provide a framework for identifying other cutoff values, thereby offering a clinical guideline that could be extrapolated to further discoveries in the dental field.

In considering the biomechanical principles in the early post-surgical phase of mandibular advancement, it’s essential to note that the distal segment can be susceptible to angular forces.(Van Sickels and Richardson, 1996) Despite achieving absolute fixation at the osteotomy site, taking into account factors such as plate insertion and para-mandibular musculature direction, a three-dimensional study on BSSO revealed significant relapse of the distal segment in a posterior, inferior, and clockwise pitch direction.(Shujaat et al., 2022) This indicates that any impact on the intersegment site could potentially result in post-surgical instability.(Mobarak et al., 2001) The transverse occlusal plane may serve as a direct reservoir for the contraction forces of the para-mandibular muscles.

This retrospective cohort study has several limitations, the general issue being follow-up period and sample size. Changes in the first post-surgical year refers to the post-surgical stability which directly relates to the surgical healing, post-surgical orthodontics, and short-term physiologic adaptation, while post-treatment stability relates to changes beyond the first year after surgery, implying long-term adaptation. Proffit et al. reported that the procedures typically used to treat Class II/long face issues are quite stable during the first post-surgical year, whereas after one to five years, a considerable number of patients experience clinically problematic skeletal changes.(Mihalik et al., 2003; Mobarak et al., 2001; Proffit et al., 2010; Proffit et al., 2007) Therefore, it is insufficient to conclude that the post-surgical stability of our study is concrete in the long term. Additionally, since our study sample consisted of 22 adults, placing emphasis on the necessity of further prospective studies involving a larger group of patients, and a longer follow up evaluation of the stability after non-surgical maxillary expansion and mandibular advancement surgery.

V. Conclusion

This study focused on the transverse aspects among the various factors related to post-surgical stability. Some patients showed more than 2 mm of horizontal movement of the mandible up to 1-year post-surgery, which posed challenges for orthodontists in stabilizing the occlusion during the postoperative orthodontic period. There are numerous aspects that can contribute to the stable occlusion after surgery and orthodontic treatment. The findings suggest that pre-surgical and post-orthodontic transverse discrepancy is related to post-surgical stability of bimaxillary surgery with mandibular advancement. To prevent instability of the mandible after advancement, the transverse aspects of the occlusion should be considered prior to surgery, and preoperative YTI analysis could be one of the solutions.

VI. References

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Abstract in Korean

성인 골격성 II급 부정교합 환자에서 수술 후 안정성과 수술 전 횡적 부조화의 상관관계

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본 후향적 연구에서는 악교정수술을 받은 골격성 II급 부정교합 환자에서 확장 후 수술 전 횡적 부조화 수치와 수술 후 안정성의 관계에 대해 알아보고자 하였다.

이를 위해 골격성 II급으로 진단받고, 악교정수술을 받은 22명의 환자(N=22, 평균 연령, 23.5세)로 구성된 표본을 조사하였으며, 피험자들은 모두 악교정수술 전에 각각 TPA, RPE, MARPE 등을 통해 상악궁 확장 치료를 받았다. 초진(T0), 수술 1개월 전(T1), 수술 1개월 후(T2), 그리고 수술 12개월 후(T3) 측모두부계측방사선 사진(Lateral cephalogram)을 통해 수술 전, 수술 중 및 수술 후 변화를 측정하였다. CBCT(cone beam computed tomography) 이미지는 T1, T2, 그리고 T3에 촬영되었고, 상악 제1대구치의 치관과 저항 중심(CR) 높이에서 구치간 폭경을 측정하였다.

수술 후 안정성은 수술 1년 후 측모두부계측방사선 사진 상에서 하악골의 수평 위치 변화가 2mm 미만인 것으로 정의하였다. 표본은 수술 후 안정성을 유지한 안정 그룹(S군)과 상대적으로 불안정한 그룹(LS군)으로 나누었다. 수술 전 악궁 간 횡적 부조화 수치는 수술 1개월 전에 측정한 Yonsei 횡적 폭경 지수(YTI)로 결정하였고, 수술 후 안정성과 YTI 값 간의 관계를 분석하기 위해 로지스틱 분석을 수행하였다. 수술 전 목표 YTI 값은 ROC 곡선을 이용하여 결정하였다.

두 그룹 간 치료 전 기본적인 특성에서 유의미한 차이는 없었으나, 수술 전에는 fossa와 CR 높이 모두에서 YTI 값의 유의미한 차이가 있었다. 두 그룹 간 악교정 수술에 의한 하악골 전진량에는 유의미한 차이가 없었다. YTI값에 따른 odds ratio는 0.35(p=0.024)로 나타났다. 수술 전 YTI를 통해 안정성을 예측한 ROC 곡선의 면적은 0.88이었으며, 이를 통해 YTI의 기준값은 1.45mm로 제시할 수 있었다. 이는 수술 전 횡적 부조화 수치가 수술 후 안정성과 상관관계를 보이며, 수술 전 단계에서 이를 특정 수준으로 교정하는 것이 수술 후 안정성을 확보하는 데 도움이 될 것으로 보인다.

핵심 되는 말: 양악 수술, 골격성 II급 부정교합, 하악골 전진술, 수술 후 안정성, 횡적 부조화, 상악궁 확장