CLINICAL ANALYSIS

http://dx.doi.org/10.5125/jkaoms.2012.38.6.354
pISSN 2234-7550 · eISSN 2234-5930

# Investigating the effect of age on skeletal stability after sagittal split ramus osteotomy for mandibular setback

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**Abstract** (J Korean Assoc Oral Maxillofac Surg 2012;38:354-9)

**Objectives:** The purpose of this study was to investigate whether the age factor would be related with stability of mandibular setback surgery for patients with mandibular prognathism.

**Materials and Methods:** We compared the relapse patterns of 47 patients divided into three age groups (termed younger, adult, and older). The younger group consisted of patients between 15 and 17 years old; the adult group was made up of patients between 21 and 23 years old, and the older group was made up of patients more than 40 years old. The positional change of B point was evaluated at preoperative, postoperative, and follow-up states.

**Results:** The horizontal relapse ratio was 21.7% in the younger group, 15.3% in the adult group, and 15.7% in the older group. Although relatively higher degrees of relapse were found in the younger group, this increase was not statistically significant. Spearman's correlation analysis was performed to explore other factors contributing to relapse. We subsequently found that the amount of relapse was related to horizontal setback.

**Conclusion:** Although the degree of relapse in younger patients is not significant;y higher compared to other groups. The major contributing factor to relapse after sagittal split ramus osteotomy is amount of setback rather than age when the surgery was performed to patients over than 15 years of age.

**Key words:** Mandibular osteotomy, Age, Relapse, Sagittal split ramus

*[paper submitted 2012. 7. 9 / revised 2012. 9. 3 / accepted 2012. 10. 8]*

## I. Introduction

The incidence of mandibular prognathism is higher among Asian patients than Caucasians[1-3]. Therefore, many mandibular setback surgeries have been performed. Bilateral sagittal split ramus osteotomy (SSRO) is widely applied in the treatment of mandibular prognathism patients. Although mandibular setback surgery is quite reliable and safe, long-term relapse had been a concern.

The contributing factors of relapse after SSRO surgery include the fixation method[4,5], change of condyle position[5,6], soft tissue or muscular activity[7-10], gender[10,11], age[12-14], amount of setback[11], growth, and remodeling[10-12]. Although many authors already investigated the degrees of relapse after the SSRO surgery, there had been no consensus as to the contribution of the age factor to relapse. Several old studies investigated the age factor and degree of relapse after the SSRO surgery, but it was a retrospective study with advance SSRO surgery on adolescents with retrognathic mandible[13-15]; hence the need to investigate the potential influence of age on relapse after setback SSRO surgery.

As already announced by Lewis and Roche[16] in 1988, mandible growth is completed at 18 years. However, the late growth of the mandible continues into the third decade, and that would influence the outcome of setback SSRO surgery[16]. Furthermore, bone healing capacity is known to decrease among elder patients; hence the higher tendency of relapse in adult patients because of muscular activity[17].

Therefore, we investigated a retrospective study with the following hypotheses after setback SSRO surgery: 1) Younger patients (below 17 years) will experience higher degree of relapse as they grow up, and; 2) Older patients (40 years and up) will also show higher degree of relapse since their bone union will be slower than that of younger patients.

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## II. Materials and Methods

### 1. Subjects

This study retrospectively reviewed a total of 47 patients with mandibular prognathism and without facial asymmetry and who underwent SSRO only for mandibular setback in the Department of Oral and Maxillofacial Surgery, Kyungpook National University Hospital between January 2005 and June 2011. The patients were divided into 3 groups by age. Group 1 (younger group) consisted of 10 patients between 15 and 17 years (male : female=1 : 9); Group 2 (adult group) was made up of 30 patients between 21 and 23 years (male : female=20 : 10), and Group 3 (older group) were consisted of 7 patients more than 40 years old (male : female=1 : 6).(Table 1)

### 2. Selection criteria

Among 172 mandibular setback surgery with SSRO patients, facial asymmetry cases (more than 3 mm dental midline deviation or more than 5 mm setback amount difference), two-jaw surgery cases, and congenital abnormal patients were excluded. Patients undergoing follow-up more than 6 months were included. Therefore, 47 patients were selected for this study.

### 3. Surgical method

Every operation was performed with interocclusal acrylic resin splint to prevent condylar position change and fixed with titanium 4-hole regular or elongated straight miniplate Mini-plate (Martin, Tuttlingen, Germany). After the operation, patients used intermaxillary fixation with elastic or wire for 1-2 weeks and interocclusal acrylic resin splint for 4-6 weeks for occlusion stabilization.

### 4. Cephalometric analysis

Skeletal changes as a result of surgery and their stability were evaluated on standardized lateral cephalograms taken with the subject standing upright and trying to assume a natural position of the head and relaxed lips and teeth in the intercuspal position. The lateral cephalograms were taken 1 month before surgery (T0), 2-3 days after surgery (T1), and at least 6 months after surgery (T3, 6-30 months). Postoperative change was defined as T0-T1, and relapse, as T1-T2. All cephalograms were taken with the same cephalostat (CX-90 sp; Asahi, Tokyo, Japan) at the Department of Oral and Maxillofacial Radiology, Kyungpook National University Hospital.(Fig. 1)

**Table 1.** Demographic data of patients before the surgery

| Group | Group 1 (younger group) | Group 2 (adult group) | Group 3 (older group) | *P*-value |
|---|---|---|---|---|
| Age | 15-17 (16.7±0.7) | 21-23 (22.0±0.7) | Over 40 (47.1±3.5) | |
| Patients (gender) | 10 (M : F=1 : 9) | 30 (M : F=20 : 10) | 7 (M : F=1 : 6) | |
| SNB (T0) | 82.34±3.47 | 82.98±4.08 | 82.98±4.08 | 0.940 |
| FH-NB (T0) | 89.94±3.53 | 91.25±3.19 | 90.47±2.00 | 0.535 |

(M: male, F: female, SNB: sella-nasion-B point angle, FH-NB: FH to nasion-B point angle)
T0 means 1 month before surgery.
Values are mean±standard deviation.
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**Fig. 1.** Lateral cephalograms were obtained before surgery (T0), 2-3 days after surgery (T1), and more than 6 months after surgery (T2).
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The obtained lateral cephalograms were digitized by V-ceph 6.0 (Osstem, Seoul, Korea) by three senior oral and maxillofacial residents with blind to the degree of mandibular setback amount and dates of operation, and the average was calculated. The traced cephalograms were overlapped at points S (sella), N (nasion), Po (porion), and Or (orbitale), and the reference point of relapse was measured at point B. Reference lines (FH plane and SN line) were then drawn based on the reference point.(Fig. 2)

### 5. Statistical analysis

The average and standard deviation were calculated for the measured distances and degrees at individual times (T0, T1, T2). Statistical differences between the groups were calculated using the Kruskal-Wallis test with SPSS version 12.0 (IBM, New York, NY, USA) for each measurement method. In addition, Spearman's correlation analysis was performed to determine other factors contributing to relapse with SPSS version 12.0.

## III. Results

For the horizontal (parallel to FH plane) relapse on B point, the younger group showed relatively high degree of relapse (21.7%) than the adult group (15.3%) or the older group

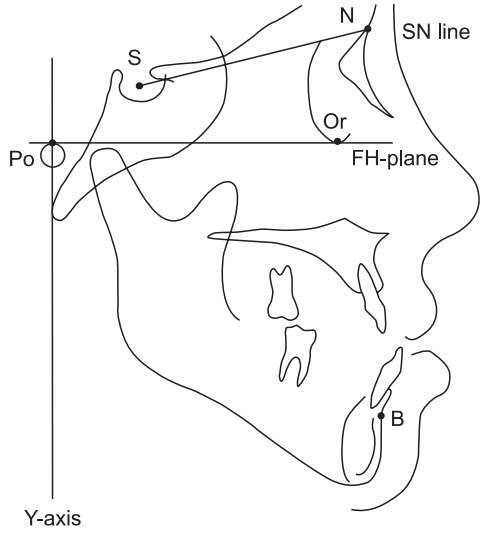


**Fig. 2.** Measurement for lateral cephalometric analysis. (N: nasion, S: sella, Po: porion, Or: orbitale, FH: frankfurt)
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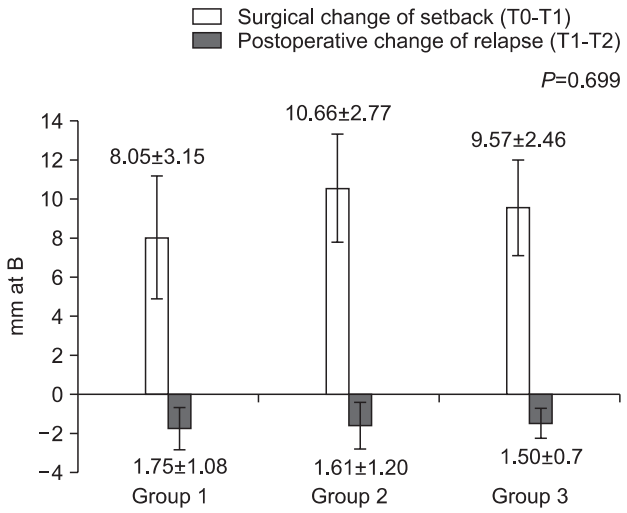


**Fig. 3.** Comparison of surgical change (B [x]) and relapse according to the groups.
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**Table 2.** Horizontal mandibular position change after surgery (Kruskal-Wallis test)

| | Group 1 | Group 2 | Group 3 | *P*-value |
|---|---|---|---|---|
| 1. Horizontal change of B point | | | | |
| Surgical change of setback (mm at B) | 8.05±3.15 | 10.56±2.77 | 9.57±2.46 | 0.428 |
| Postoperative change of relapse (mm at B) | 1.75±1.08 | 1.61±1.20 | 1.50±0.77 | 0.875 |
| Degree of relapse (%) | 21.74±11.84 | 15.25±11.69 | 15.67±6.94 | 0.699 |
| 2. Angular change of SNB | | | | |
| Preoperative degree of SNB | 82.34±3.47 | 82.98±4.08 | 82.98±4.08 | 0.940 |
| Surgical change of SNB | 5.10±1.74 | 5.04±1.42 | 5.41±2.75 | 0.938 |
| Postoperative change of SNB | 1.20±0.73 | 0.73±0.62 | 0.94±0.59 | 0.140 |
| Degree of relapse (%) | 23.53±13.12 | 14.48±13.88 | 17.38±13.38 | 0.280 |
| 3. Angular change of FH-NB | | | | |
| Preoperative degree of FH-NB | 89.94±3.53 | 91.25±3.19 | 90.47±2.00 | 0.535 |
| Surgical change of FH-NB | 4.93±1.86 | 5.00±1.41 | 5.21±1.21 | 0.938 |
| Postoperative change of FH-NB | 1.07±0.82 | 0.76±0.67 | 0.82±0.47 | 0.597 |
| Degree of relapse (%) | 21.70±14.37 | 15.20±13.93 | 15.74±7.13 | 0.451 |

(SNB: sella-nasion-B point angle, FH-NB: FH to nasion-B point angle)
Values are mean±standard deviation.
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(15.7%). Furthermore, the older group exhibited a relatively higher degree of relapse than the adult group. Based on the statistical analysis, however, the difference (*P*=0.699) was not statistically significant.(Table 2, Fig. 3)

Other results with regard to different measurement methods also showed similar outcome. The sella-nasion-B point angle (SNB) change showed a 23.5% relapse in the younger group, which was higher than that of other groups (14.5% in the adult group, 17.4% in the older group). A difference in SNB change was also noted between the older group and the adult group, but it was not statistically significant (*P*=0.280).(Table 2)

The FH to nasion-B point angle (FH-NB) change also showed higher degree of relapse in the younger group (21.7%) than the other groups (15.2% in the adult group, 15.7% in the older group) and relatively higher relapse in the older group than the adult group. The differences were not statistically significant, however (*P*=0.451).(Table 2)

Spearman's correlation analysis was done to determine other factors (SNB [T0], FH-NB [T0], surgical change of SNB and FH-NB degrees) contributing to relapse. As a result, the amount of setback (r=0.365, *P*=0.012) was found to be related more to the degree of relapse than the age factor. There was also no statistically significant difference in terms of the influence of the age factor (r=-0.079, *P*=0.596).(Table 3)

## IV. Discussion

The incidence of skeletal Class III was reportedly 9.4-19.0% in Korea whereas 1.0-3.8% in Caucasian races[1-3]. In the treatment of skeletal class III patients, almost treatment of mandibular prognathism includes surgical procedure (i.e., SSRO with or without Le Fort I osteotomy or genioplasty). Accordingly, many studies had been done to minimize surgery complications and to improve surgical skills. Therefore, the reliability of surgical procedures has been improved to the point that there are now few complications. Furthermore, esthetic demands increased together with the need for the treatment of skeletal prognathism in Korea. As such, nowadays, orthognathic surgery is popular among young students or older patients as well as adult patients.

Since Obwegeser and Dal Pont first introduced the surgical method to correct mandibular prognathism and retrognathism, the SSRO method has been widely accepted as a method of correcting mandibular deformity[18,19]. Therefore, many previous research studies dealt with SSRO surgery and concluded that some degree of relapse would occur after the setback SSRO surgery[4,8]. Those studies also revealed the cause of relapse after SSRO and invented many methods (i.e., modified surgical method, fixation method, use of interocclusal acrylic splint, condyle repositioning techniques, etc.) to prevent relapse after SSRO surgery. The fixation method[4,5], change of condyle position[5,6], soft tissue or muscular activity[7-10], gender[10,11], amount of setback[11], growth, and remodeling[10-12] were identified as the causes of relapse after operation. Although the age of patients could be easily assumed to influence the surgical prognosis, no study was mentioned with regard to the degree of relapse in setback SSRO surgery according to the age factor.

Since no such studies existed, we investigated 10 young patients (15-17 years, 16.7±0.7) who finished the pubertal growth spurt and 7 old patients (43-53 years, 47.1±3.5) retrospectively in setback SSRO surgery but found no statistical difference between the groups even as the younger group seemed to show higher degree of relapse than the adult group. We took hand-wrist radiographs to every young patients to confirm finishing pubertal growth spurt. Although the male to female ratio was not uniformly distributed in our study, we quoted the result of Mobarak et al.[11] in 2000, i.e., the influence of gender on post-surgery response was very minimal in SSRO cases[18].

There were previous studies that investigated the influence of age factor in advancement SSRO surgery. According to Wolford et al.[13], the results of mandibular advancement SSRO

**Table 3.** Result of Spearman's correlation analysis

| Correlation analysis | Preoperative condition (T0) | | Postoperative change (T0-T1) | | | Age |
|---|---|---|---|---|---|---|
| | SNB (T0) | FH-NB (T0) | ΔB (x) (T0-T1) | ΔSNB (T0-T1) | ΔFH-NB (T0-T1) | |
| ΔB (x) (T1-T2) | r=0.119<br>*P*=0.901 | r=0.053<br>*P*=0.726 | r=0.365<br>*P*=0.012 | r=0.291<br>*P*=0.047 | r=0.276<br>*P*=0.000 | r=-0.079<br>*P*=0.596 |

(SNB: sella-nasion-B point angle, FH-NB: FH to nasion-B point angle, SNB (T0): SNB degree at preoperative state, FH-NB (T0): FH-NB degree at preoperative state, ΔB (x) (T0-T1): amount of surgical change at B point, ΔSNB (T0-T1): change of SNB degree between preoperative and postoperative states, ΔFH-NB (T0-T1): change of FH-NB degree between preoperative and postoperative states, ΔB (x) (T1-T2): amount of horizontal relapse at B point)

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surgery in 12 growing patients (8-16 years) were stable - with minimal relapse during the follow-up period - and the maxilla and mandible exhibited harmonious, coordinated growth after surgery. Huang and Ross[14] published their results on mandibular advancement SSRO in 22 growing patients (8.7-16.9 years) and declared that more than 10 mm advancement would show not only lack of growth but also a decrease in the size of the condyle. Schendel et al.[15] reported the results of mandibular advancement SSRO surgery in 12 growing patients (8-16 years) particularly the normal and coordinated growth of the facial skeleton and minimal relapse during the follow-up period. Whereas these studies investigated the influence of age factor after SSRO surgery in young patients with retrognathism, we found in our study that there was no statistical difference in the degree of relapse according to the patient's age after the setback SSRO surgery.

In older patient groups, there was no literature on the prognosis after the SSRO surgery. Unioning distal and proximal segments is known to take longer time in old patients than in younger patients. Thus, we supposed that older patients would experience higher degree of relapse compared to adult patients because of the soft tissue and muscle function surrounding the mandible. Note, however, that there were no statistical differences between the groups even as slightly higher degree of relapse (15.7±6.9%) was noted compared to the adult group (15.3±11.7%). We performed concomitant mandibular angle resection combined with SSRO as suggested by Kim et al.[7]. The surgical method has the advantages of reduction of the pterygomasseteric muscle sling tension and more esthetic results after the setback SSRO surgery[7].

To exclude other factors contributing to relapse, we performed the same surgical procedures on patients. For fixation, we used miniplate with monocortical screws and interocclusal acrylic resin splint to prevent condyle position change.

Trauner and Obwegeser[18] first introduced the SSRO surgery wherein the distal and proximal segments were fixed with wire. Such resulted in higher degree of relapse in the early days. Continuous studies led to the rigid internal fixation (RIF) being devised to fix proximal and distal segments after splitting the ramus. Since RIF using bicortical screws or miniplates with monocortical screws were first described in SSRO surgery by Spiessl[20] in 1974, nowadays, RIF method is widely accepted, becoming the standard for SSRO surgery. There are some studies comparing relapse using bicortical screw or miniplates with monocortical screws[4,5]. Although Ochs[21] declared that using 3 bicortical screws provides the most cost-effective, rigid, and predictable way to fix the segments, using miniplate with monocortical screws has the advantage of reducing the risk of temporomandibular dysfunction syndrome because the proximal segment can adjust its position after osteotomy[21,22]. Furthermore, Harada and Enomoto[5] experimentally compared stability using titanium screw and Poly-$_L$-lactic acid (PLLA, biodegradable) screws and concluded that there was no statistical difference between the two groups. Choi et al.[4,9] evaluated the postoperative relapse between the use of miniplates and bicortical screws and reported that there was little influence on the stability between the two groups.(Table 4) Although using miniplates with monocortical screws has the disadvantage of cost, it minimizes the side effect of condyle dysfunction. Thus, miniplate is usually used with monocortical screws to fix mandibular segments in our clinic.

After the SSRO surgery, the intercondylar width tends to decrease after setback and to increase after advancement. Furthermore, this trend becomes obvious in rigid fixation with bicortical screws. A change in axial inclination involving either medial or lateral rotation of the condylar axis occurs, with inward rotation more frequent with mandibular retropositioning and rigid screw fixation[23]. To prevent the rotation of proximal segment, several devices were introduced and used in operation[12,24]. In our clinic, we used interocclusal acrylic resin splint to prevent the condyle location change.

Other contributing factors of relapse after SSRO were

**Table 4.** Comparison of relapse degree by fixation method after SSRO

| Study | Fixation method | Patients (n) | Follow-up | Mean setback (mm) | Relapse (mm), % |
|---|---|---|---|---|---|
| Choi et al.[4] | RIF | 71 | 2 years | 7.8 | 0.9 (Pg), 11.5 |
| (Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2000) | Semi-rigid | 15 | | 8.2 | 1.1 (Pg), 13.4 |
| Harada and Enomoto[5] | RIF | 10 | 12 months | 6.7 | 0.94 (B), 14.0 |
| (J Oral Maxillofac Surg, 1997) | Semi-rigid | 10 | | 6.6 | 1.05 (Pg), 15.7 |

(SSRO: sagittal split ramus osteotomy, RIF: rigid internal fixation, Reference points Pg: pogonion, B: B point)

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amount of setback, late growth, and remodeling. According to previous studies, however, those factors are just little reasons of relapse[10-12].

Furthermore, we investigated other factors contributing to relapse degree and found that horizontal setback (r=0.365, *P*=0.012) is more related to the degree of relapse than the age factor (r=-0.079, *P*=0.596) using Spearman's correlation analysis. Although the correlation between the amount of setback and relapse degree was not dealt with in previous studies, in our study, horizontal setback seems to be more responsible for relapse[8,11].

## V. Conclusion

We investigated 47 patients with skeletal Class III malocclusion with mandibular prognathism and without facial asymmetry and who underwent SSRO for mandibular setback in the Department of Oral and Maxillofacial Surgery, Kyungpook National University Hospital through retrospective review. The following conclusions were drawn:

1. The younger group showed relatively high degree of relapse (1.20±0.73 mm, 23.53±13.12% at B point) than the other groups, but the difference was not statistically significant.
2. In the older group, the degree of relapse was slightly higher compared to the control group. The difference between the groups was not statistically significant, however.
3. The horizontal relapse of the mandible was more related to the amount of setback than the age factor of the patients.

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