Skeletal Stability after a Mandibular Setback Using Sagittal Split Osteotomy Fixed by Titanium Miniplates or Two Screws

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Abstract

Rigid internal fixation after bilateral sagittal split osteotomy (BSSO) is routinely used worldwide. However, stability of the mandible one year after surgery with two bicortical screws at the superior border or a four-hole straight miniplate after the BSSO has not been studied clinically. Therefore, the purpose of this study was to compare two bicortical 2.7 mm ϕ screws with a four-hole straight miniplate after the BSSO and to discuss which method is more stable. The $\angle$ MP-FH with two bicortical 2.7 mm ϕ screws showed a significantly larger increase during the first year, compared to those with a four-hole straight miniplate. Thus result suggest that a single four-hole straight miniplate can provide better postsurgical stability than two bicortical 2.7 mm ϕ screws for sagittal split setback.

Key words: Postoperative skeletal stability/Sagittal split osteotomy/Miniplate/
Two bicortical screws

Introduction

Rigid internal fixation after bilateral sagittal split osteotomy (BSSO) is routinely used worldwide¹⁻⁵⁾. Several comparative studies of fixation after BSSO using screws or plates have been published^{6,7)}. Different number, types and positions of screws or plate(s) were used in these studies. In general, a straight miniplate was used, or two or three screws

placed transorally at the superior border of the mandibular fragments after BSSO. We used two bicortical 2.7 mm ϕ screws or a four-hole straight miniplate with four screws (2.0 mm $\times$ 5.0 mm or 2.0 mm $\times$ 7.0 mm) at the superior border after BSSO in prognathism patients.

Stability of the mandible one year after surgery with two bi-cortical screws at the superior border or a four-hole straight miniplate after the BSSO has not been studied clinically. The purpose of this study was to compare two bicortical 2.7 mm ϕ screws with a four-hole straight miniplate after a mandibular setback using the BSSO and to discuss which method is more stable.

Materials and Methods

Thirty-eight patients with mandibular prognathism (Male: 16, Female: 22, mean age: 21.3 ± 3.5 years old) had setback surgery using BSSO by the same surgeon (Table 1). Two bicortical linear screws (2.7 mm diameter) were placed on each side at the superior border in fourteen patients (Group I, Fig.1-upper). A four-hole straight miniplate was secured with four monocortical screws (2 mm diameter, 5 or 7 mm length) on each side after BSSO in twenty-four patients (Group II, Fig.1-lower).

The subjects were placed into intermaxillary fixation for two weeks using an interocclusal splint.

Lateral cephalometric radiographs at 1 week before and after surgery, and 1 year after surgery were used to evaluate the changes in postsurgical mandibular position. All tracings and measurements were made by one of the authors using a superimposition technique. Six measurements ($\angle$ SNB, $\angle$ ANB, mandibular plane angle ($\angle$ MP-FH), gonial angle ($\angle$ Go), overjet and overbite) were used to evaluate postsurgical mandibular changes. Student t-tests for unpaired data were used to calculate the significance of differences between the two groups.

Table 1 Patient's characteristics in 38 patients
(Group I: 14 cases, Group II: 24 cases)

	Group I		Group II	
	Mean	SD	Mean	SD
Age (yr)	20.6	3.0	21.6	3.7
Female (%)	57.1		58.3	
$\angle$ SNA ($^{\circ}$)	80.9	4.1	82.5	3.2
$\angle$ SNB ($^{\circ}$)	84.8	4.9	86.1	3.3
$\angle$ ANB ($^{\circ}$)	-3.9	1.8	-3.5	2.0
$\angle$ MP-FH ($^{\circ}$)	29.7	4.6	28.8	5.2
$\angle$ Go ($^{\circ}$)	133.4	6.6	128.9	5.9
Overjet (mm)	-4.4	1.9	-4.3	2.7
Overbite (mm)	0.9	1.6	0.9	1.6

Group I: Two bicortical screws of each side

Group II: One 4-hole straight miniplate of each side

Fig.1 upper: Two 2.7 mm bicortical screws.
Lower: A four-hole straight miniplate with monocortical screws

Results

The skeletal changes with surgical operation on $\angle$ SNB and $\angle$ ANB were -3.6 ± 2.3 and -3.7 ± 2.1 degrees in Group I and -3.7 ± 1.9 and -3.8 ± 1.8 degrees in Group II (not significantly different). The skeletal changes with surgical operation on $\angle$ MP-FH and $\angle$ Go in Group I decreased significantly more than those in Group II. The amount of setback as reflected by the change in overjet with surgery was $8.0 \text{ mm} \pm 1.9 \text{ mm}$ in Group I and $7.3 \text{ mm} \pm 2.7 \text{ mm}$ in Group II. The skeletal changes with surgical operation on overbite were $0.8 \text{ mm} \pm 2.1 \text{ mm}$ in Group I and $1.0 \text{ mm} \pm 1.6 \text{ mm}$ in Group II (Table 2).

The changes in $\angle$ SNB and $\angle$ ANB from a week to a year after surgery were 0.6 ± 1.2 and 0.4 ± 1.0 degree in Group I and 0.7 ± 1.1 and 0.5 ± 1.3 degree in Group II (not significant). The

Table 2 Changes in landmarks 1 week before and after surgery
(Group I: 14 cases, Group II: 24 cases)

	1 week after surgery - 1 week before surgery			
	Group I		Group II	
	Mean	SD	Mean	SD
∠SNB (°)	-3.6	2.3	-3.7	1.9
∠ANB (°)	-3.7	2.1	-3.8	1.8
∠MP-FH (°)	-4.5	4.1	** -0.1	3.2
Go (°)	-11.1	5.6	* -6.5	4.9
Overjet (mm)	8.0	1.9	7.3	2.7
Overbite (mm)	0.8	2.1	1.0	1.6

*:p<0.05 **:p<0.01

Group I: Two bicortical screws of each side

Group II: One 4-hole straight miniplate of each side

Table 3 Changes in landmarks from 1 week to a year after surgery
(Group I: 14 cases, Group II: 24 cases)

	1 year after surgery - 1 week after surgery			
	Group I		Group II	
	Mean	SD	Mean	SD
∠SNB (°)	0.6	1.2	0.7	1.1
∠ANB (°)	0.4	1	0.5	1.3
∠MP-FH (°)	1.8	1.6	** -0.1	1.9
Go (°)	2.8	3.1	0.9	4.4
Overjet (mm)	-0.5	1.6	-0.4	1.4
Overbite (mm)	-0.2	0.8	0.3	0.5

*:p<0.05 **:p<0.01

Group I: Two bicortical screws of each side

Group II: One 4-hole straight miniplate of each side

∠MP-FH increased more (significantly) in Group I than in Group II for the first year after surgery. The changes in the ∠Go over the first year were not significantly different between the two groups. Small decreases in overjet was recognized in both groups during the first year after the surgery. A small decrease in overbite was recognized only in Group I during the first year after the surgery (not significant) (Table 3).

Discussion

Many surgeons began to use rigid skeletal fixation after BSSO in the 1980s⁸⁾. Three bi-cortical screws placed in a triangular pattern were more effective than wire fixation for stabilizing the fragments⁵⁾. However, there were some disadvantages, including scars on the cheek from use of a trochar, nerve damage and rotation of the proximal segment. Most

patients with jaw deformities dislike the skin incision required in order for transbuccal instrumentation to place the screws. For this reason, we used two bicortical screws at the superior border of the mandible or a 4-hole straight miniplate transorally put in place without skin incisions after the BSSO. This study was undertaken to determine if there was a difference in stability between them.

Anucul *et al.*⁹⁾ reported that a 4-hole monocortical plate applied on bovine ribs provided less rigidity and was more susceptible to deformation than were three bicortical screws placed in a triangular pattern. In 1998, Tharanon¹⁰⁾ compared the stability of three bicortical linear screws at the superior border or a single 4-hole miniplate after setback using the BSSO in cadaver mandibles³⁾. His results showed that there was no statistically significant difference in stability between the two techniques. In 1996, Shetty *et al.*¹¹⁾ reported that osteotomy sites stabilized with 2.4 mm screws were more stable than those stabilized with 2.0 mm screws. Further, three screws were more stable than two linear screws at the superior border. However, Schwimmer¹²⁾ reported in his experimental study that there were no statistically significant differences between the strength achieved with the different screw sizes, or by placing the screws using lag or positional techniques. Foley and Beckman¹³⁾ reported that experimental osteotomies stabilized with three 2.0 mm screws in an inverted-L pattern and those with one monocortical miniplate were significantly more rigid than those stabilized with two 2.7 mm ϕ screws placed in a linear pattern. Results of in-vitro studies suggest that three 2.0 mm screws placed in a triangular pattern or a single 4-hole straight miniplate fixation after sagittal split osteotomy is more stable than two linear 2.7 mm screws ϕ at the superior border of the fragments. The repeated force of the masticatory muscles and bone healing during the maxillomandibular fixation in humans did not seem to influence these experimental results.

Choi *et al.*⁶⁾ compared the short term stability of a miniplate versus three bicortical screws after sagittal split setback in humans. There were no significant differences between the two groups. Fujioka⁷⁾ compared the stability of two lag screws with a 3-D miniplate with four monocortical screws after sagittal split setback in 32 prognathic patients. His results showed that there was no significant difference in $\angle$ SNB and $\angle$ MP-FH. However, it was suggested that mandibles stabilized with the 3-D plate were more changeable postoperatively than two lag screws.

In our study, the changes of $\angle$ SNB and $\angle$ ANB (used as one of the indices of postsurgical horizontal relapse) increased a little in both groups, without significant differences between them. The relapse tendency of SNB in study was very similar to previous reports¹⁻⁵⁾.

Lai *et al.*¹⁾ reported that the change of SNB 6 months after sagittal split setback with 4-hole straight miniplate was 0.44 degree and 9.8 % relapse. Ingerval *et al.*³⁾ reported that sagittal split setback relapsed an average of 1.1 to 1.3 mm, so that the mean net effect was 80 % at follow-up. Shepherd *et al.*¹⁴⁾ also reported that mean horizontal relapse at 6 months (mean: 0.6 mm, maximum: 1.5 mm) was 8 % of operative movement. Our result was 16.7 % in Group I, 18.9 % in Group II at one year after the BSSO. The $\angle$ MP-FH in our study was

significant different in the two groups. The $\angle$ MP-FH with two bicortical 2.7 mm ϕ screws showed a significantly larger increase during the first year, compared to those with a 4-hole straight miniplate. It seems that two bicortical 2.7 mm screws at the superior border of the fragments after BSSO were less able to resist the forces of postsurgical clockwise rotation than those with three triangular screw fixation or a 4-hole straight miniplate.

These results suggest that a single 4-hole straight miniplate can provide better postsurgical stability than two bicortical 2.7 mm screws for sagittal split setback. We believe that the postsurgical stability with a single 4-hole straight miniplate after the sagittal split setback is adequate and provides satisfaction to the patients concerning their postsurgical profile and occlusion.

References

- 1) Lai W, Yamada K, Hanada K, Ali IM, Takagi R, Kobayashi T, Hayashi T. Postoperative mandibular stability after orthognathic surgery in patients with mandibular protrusion and mandibular deviation. *Int J Adult Orthodontic Orthognath Surg* 17: 13-22, 2002.
- 2) Mobarak KA, Krogstad O, Espeland L, Lyberg T. Long-term stability of mandibular setback surgery: a follow-up of 80 bilateral sagittal split osteotomy patients. *Int J Adult Orthodontic Orthognath Surg* 15: 83-95, 2000.
- 3) Ingervall B, Thuer U, Vuillemin T. Stability and effect on the soft tissue profile of mandibular setback with sagittal split osteotomy and rigid internal fixation. *Int J Adult Orthodontic Orthognath Surg* 10: 15-25, 1995.
- 4) Abeloos J, De Clercq C, Neyt L. Skeletal stability following miniplate fixation after bilateral sagittal split osteotomy for mandibular advancement. *J Oral Maxillofac Surg* 51: 366-369, 1993.
- 5) Proffit WR, Phillips C, Dann C, Turvey TA. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. I. Mandibular setback. *Int J Adult Orthodontic Orthognath Surg* 6: 7-18, 1991.
- 6) Choi B, Min Y, Yi C, Lee W. A comparison of the stability of miniplate with bicortical screw fixation after sagittal split setback. *Oral Surg Oral Med Oral Path* 90: 416-419, 2000.
- 7) Fujioka M, Fujii T, Hirano A. Comparative study of mandibular stability after sagittal split osteotomies: Bicortical versus monocortical osteosynthesis. *Cleft Palate-Craniofac J* 37: 551-555, 2000.
- 8) Tulasne JF, Schendel SA. Transoral placement of rigid fixation following sagittal ramus split osteotomy. *J Oral Maxillofac Surg* 47: 651-652, 1989.
- 9) Anucul B, Waite PD, Lemons JE. In vitro strength analysis of sagittal split osteotomy fixation: Noncompression monocortical plates versus bicortical position screws. *J Oral Maxillofac Surg* 50: 1295-1299, 1992.
- 10) Tharanon W. Comparison between the rigidity of bicortical screws and a miniplate for fixation of a mandibular setback after a simulated bicortical sagittal split osteotomy. *J Oral Maxillofac Surg* 56: 1055-1058, 1998.
- 11) Schetty V, Freymiller E, McBrearty D, McBrearty D. Functional stability of sagittal split ramus osteotomies: Effects of positional screw size and placement configuration. *J Oral Maxillofac Surg* 54: 601-609, 1996.
- 12) Schwimmer A, Greenberg AM, Kummer F, Kaynar A. The effect of screw size and insertion technique on the stability of the mandibular sagittal split osteotomy. *J Oral Maxillofac Surg* 52: 45-48, 1994.

- 13) Foley WL, Beckman TW. In vitro comparison of screw versus plate fixation in the sagittal split osteotomy. *Int J Adult Orthodon Orthognath Surg* 7: 147-150, 1992.
- 14) Shepherd JP, Dohvoma CN, Harradine NWT. Screw fixation after mandibular sagittal split osteotomy: an intra-oral approach. *Br J Oral Maxillofac Surg* 29: 325-329, 1991

下顎前突症症例において下顎枝矢状分割術で後方移動する際の ミニプレート固定法と2本のネジ止め固定法との 術後骨格安定度について

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抄 録

下顎枝矢状分割時の近遠位骨片固定法は近年、ネジのみによる固定法とミニプレートによる固定法が多くの施設で行われている。しかし、その術後の骨格安定度を比較した研究は少ない。下顎前突、反対咬合を有する顎変形症患者で両側に下顎枝矢状分割術を施行した症例で、近遠位骨片の接合に口腔内から2.7 mmのネジ2本で固定した14症例と4穴ミニプレートを外側皮質骨のみに固定した24症例の2群に分けて検討した。2群間の年齢、性別、側方X線規格写真で得られた角度および前歯被蓋関係に有意差のない38症例とした。2.7 mmのネジ2本の近遠位骨片の接合部位は口内法で下顎枝前縁上方に骨間貫通法とした。4穴ミニプレート使用群はネジ2本群と同様に口内法で2.0×5.0 mmネジもしくは2.0×7.0 mmネジ4本にて下顎7番部頰側から下顎枝前縁上方に外側皮質骨のみに固定した。

これら2群の術後骨格安定度は術前1週間前、術後1週間後と術後1年後の側方X線規格写真を用いて比較検定した。

その結果、術前後の1週間の差において、 $\angle$ SNB、 $\angle$ ANBに有意差はなかった。しかし、 $\angle$ MP-FH、 $\angle$ Goにおいてネジ2本群はミニプレート群より有意に反時計回り回転が大きかった。術後1週間目と術後1年目の差においても、B点における有意差はなかった。しかし、 $\angle$ MP-FHにおいてネジ2本群はミニプレート群より有意に時計回りに移動していた。

以上より、下顎枝矢状分割で遠位骨片を後方移動する際の骨片固定は、下顎枝前方のネジ2本による固定よりミニプレートとネジ4本による固定法の方が術後の骨格安定度において優れていることが示唆された。

キーワード：術後骨格安定性/下顎枝矢状分割術/ミニプレート/骨間貫通ネジ