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ABSTRACT

Background and objective: This study aimed at assessing the skeletal stability of adjustable mini plates in comparison to conventional mini plates following bilateral sagittal split ramus osteotomy (BSSRO)

Materials and Methods: Fourteen patients were divided into 2 equal groups. Patients in both groups underwent BSSRO and mandibular setback. In the study group, the bone segments at the osteotomy site were stabilized using the adjustable plates and four 2.0 mm monocortical screws. In the control group, bone segments at the osteotomy site were stabilized using conventional mini plates and four 2.0 mm monocortical screws. Each patient was assessed in terms SNB, mandibular plane angle (MPA) recorded in degrees (°) and horizontal and vertical changes of the B-Point recorded in millimeters (mm).

Results: Skeletal stability was contemporaneous in both groups with an insignificant difference regarding the assessment criteria. However, adjustable plates showed the advantage of decreasing operative time when occlusion is not perfect at the release stage and adjustments were required.

Conclusion: The choice of the fixation method should combine between sufficient stability for early jaw mobilization and elasticity to allow for intraoperative and early postoperative corrections. Such requirements were met by the adjustable plates.

KEYWORDS: BSSRO, adjustable plates, fixation.

Introduction

Dentofacial deformity signifies significant unconventionalities from ordinary scopes of the maxillomandibular complex. In 1907, ***Angle*** described Class III malocclusion as when "the lower first molar is in a mesial positioned in relation to the upper first molar". This type of deformity includes a relatively trivial segment of the regular orthodontic run through. However, these cases are among the most challenging to be treated effectually and productively.[(1)]

Skeletal class III malocclusions were alleged to be solely accredited to an outsized and/or prominent mandible, this was till the 1970s. But in reality, it can be the product of mandibular prognathism with a customarily situated maxilla, maxillary retrognathism with a normal mandible or mixture of maxillary retrognathism and mandibular prognathism.[(2)]

The prime goals of successful orthognathic surgery are the restoration of normal jaw function, optimal facial esthetics, and long-term stability. The most common orthognathic practice is a bilateral sagittal split ramus osteotomy (BSSRO) to setback or advance the mandible. From a surgeon's point of view, long-term stability following BSSRO may be the most imperative thing to accomplish.[(3)]

Several methods of fixation are used to achieve acceptable postoperative stability, including bicortical screws or mini plates. These means are used to position the proximal and distal segment after BSSRO. Several studies have been conducted comparing the postoperative skeletal stability between different types of osteosyenthesis.[(4)]

The presented study is to investigate the postoperative skeletal stability following BSSRO in mandibular setback surgeries using adjustable versus monocortical mini plates by identifying the horizontal and the vertical changes of mandibular position through lateral cephalometry.

Materials and Methods

Materials

Study group

The plates used in our study were the 2.0 Dr. SABOYE adjustable plates on site manufactured by GlobalD, France. The plate was 1 mm thickness and consisted of 2 vertical plates – a long and a shorter one - connected by two adjustable arms. The long plate is was 15mm and the short one was 12mm. The distance between the two plates was 17mm having an adjustable joint in each arm that could be modified using plate-specific pliers accompanying the kit, the joints were either expanded or compressed to achieve the desired result. This was to allow anterior, posterior, clockwise and counter-clockwise directional change.

Comparator group

Conventional 4-hole with space monocortical mini plates and screws were used.

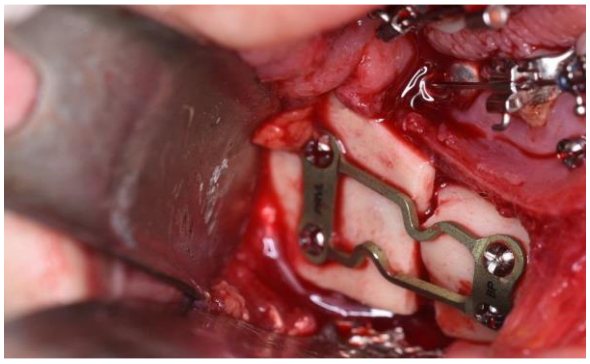


Fig. 1: Adjustable plate placement after osteotomy

Study population

14 patients were selected suffering from class III skeletal relationship. The history and detailed medical examination data for each patient was collected in a chart prepared specially for this study. Standard preoperative patients' photographs were taken. Fabrication of intermediate and final dental splint was carried out on the surgical model conventionally.

Clinical data

Mandibular range of motion, occlusion, wound healing, temporomandibular joint dysfunction syndromes and inferior alveolar nerve paresthesia in addition to other complications as infection or facial nerve injury was evaluated for each patient.

Radiographic data

Radiographic follow-up was achieved through lateral cephalometric radiographs. Panoramic radiographs were ordered immediately postoperatively to check the condylar position and the location of plates and screws. Lateral cephalometric radiographs were ordered immediate postoperative (F1), 3 months (F2), 6 months (F3), and 1 year postoperatively (F4) to develop cephalometric analysis which compared that performed preoperatively (F0) to evaluate the surgical changes and the amount of relapse. All radiographs were traced using Dolphin software using Wits and Stiener analysis.

The Data collected included angular measurements, SNB (the angle formed between the anterior cranial base (S-N) and a line drawn through N and B point), MPA (The angle formed between the mandibular plane (Go-Me) and the anterior cranial base (S-N)) recorded in degrees (°) and horizontal and vertical changes of the B-Point (the innermost point on the contour of the mandible) recorded in mm.

Horizontal changes at B-point were measured and calculated by a perpendicular line to Frankfort horizontal plane (FH) (The plane demonstrated by a line through the orbitale and porion) passing through Nasion (N) point. Vertical changes at B-point were measured and calculated from perpendicular to FH line. Changes to these landmarks were recorded at 2 different time intervals, F0-F1 (representing the surgical change) and F1-F4 (representing the amount of relapse). Posterior movement of the mandible was represented by negative values while anterior movement was represented by positive values. On the other hand, superior movement of the mandible was represented by positive values while inferior movement was represented by negative values.

Results

Male to female ratio was 0.75 (6 males and 8 females) with average age group of 24.1 (22–27 y). All patient had class III skeletal relationship, eight required bimaxillary surgery and only six patients required only mandibular setback.

Surgical results:

For all patients, the surgical procedures were performed without any major complications. All inferior alveolar nerves were either embedded in the distal segment or visible but embedded in the distal segments. However, in two cases a bad split occurred on the left side of the mandible in one case and on the right side in the other during splitting and the decorticated fragment was fixed again in place using mini plates.

Clinical results:

The early postoperative period for all patients went uneventful with no significant complications. All patients showed postoperative edema with variable degrees. Patients who underwent single jaw surgery had mild edema which had resolved within 1-2 weeks, while patients who underwent bimaxillary surgery showed severe edema which resolved in 2 – 4 weeks. Early mandibular function was started for both groups. All patients were satisfied with the esthetic results.

Radiographic results

SNB and MPA

Concerning SNB, for the mean percentages of relapse showed no statistically significance differences between the two groups at F0 to F4. However, there was a statistically significant difference between the two groups regarding the mean percentages of relapse. Concerning MPA, there was no statistical differences between the two groups regarding the mean percentages of relapse.(Table 1)

Table 1: Comparison of the means and standard deviation values of SNB and MPA in the different time periods.

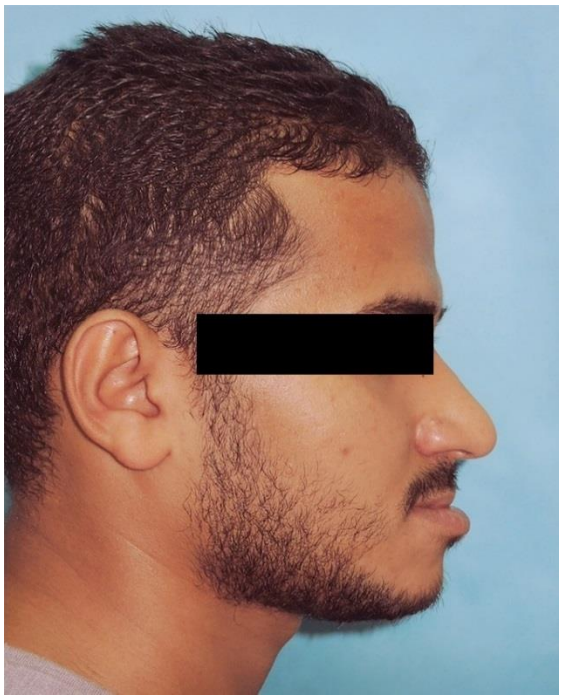
		F0		F1		F2		F3		F4		Relapse%	
		Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value
SNB	Group I	84.82 ± 4.20	0.749	79.17 ± 2.74	1.000	79.82 ± 2.85	0.485	80.35 ± 3.16	0.302	80.82 ± 3.35	0.239	2.02 ± 0.72	0.000*
	Group II	86.1 ± 4.93		79.81 ± 4.57		81.34 ± 4.72		82.62 ± 4.58		83.42 ± 4.42		4.55 ± 0.84	
MPA	Group I	34.77 ± 3.06	0.994	31.6 ± 3.0	0.757	32.27 ± 3.1	0.485	32.75 ± 3.0	0.305	33.25 ± 3.01	0.239	4.99 ± 1.0	0.226
	Group II	34.75 ± 3.61		31.65 ± 3.64		32.42 ± 3.72		33.08 ± 3.66		33.75 ± 3.72		6.25 ± 1.76	

B - Point horizontal and vertical

For B horizontal, the mean percentages of relapse showed no statistically significant differences between the two groups at F0-F1 and F1-F4. In addition, there was no statistical differences between the two groups regarding the mean percentages of relapse. For B vertical, the mean percentages of relapse showed no significant differences between the two groups at F0-F1 and F1-F4. There was a statistical difference between the two groups regarding the mean percentages of relapse.(Table 2)

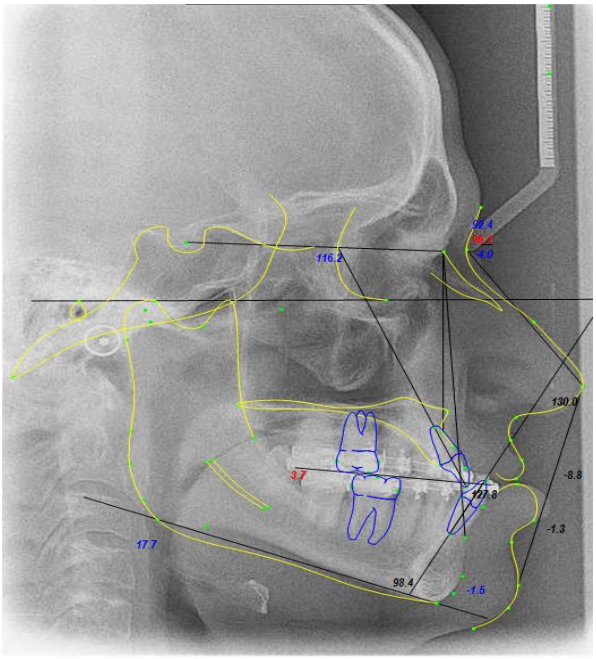
Table 2: Comparison of the means and standard deviation values of B point in a horizontal and vertical direction in the different time periods.

		F0-F1		F1-F4		Relapse%	
		Mean±SD	P-value	Mean±SD	P-value	Mean±SD	P-value
B Horizontal	Group I	-4.87±1.46	0.075	1.47±0.30	0.850	32.76±12.76	0.357
	Group II	-5.02±1.31		1.87±0.45		38.23±8.5	
B Vertical	Group I	1.67±0.60	0.321	-0.66±0.16	0.478	44.43±18.93	0.461
	Group II	2.07±0.80		-0.73±0.20		38.22±10.33	



(a)

(b)



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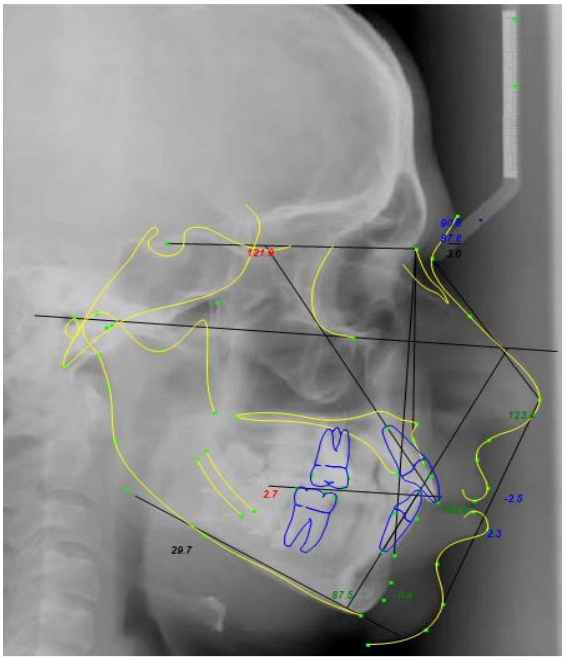

(d)

Fig. 2 (a) Preoperative clinical photo, (b) postoperative clinical photo, (c) Preoperative lateral cephalometry, (d) 12months post-operative lateral cephalometry

Discussion

BSSRO is the gold standard surgical technique used for mandibular advancement and setback. Postoperative relapse is the most common drawback. With the advent of rigid internal fixation across the osteotomy site, uncontrolled skeletal relapse is unlikely to occur. Skeletal remodeling at the site of osteotomy and the mandibular condylar heads may postoperatively continue up to one year. At the time of the sagittal splitting of the mandible, it is imperative to precisely position the proximal mandibular segment prior to fixation application.[5]

Many factors can influence the postoperative stability of the mandible, including the amount of setback, postoperative re-orientation of the pterygomasseteric sling, the bowing effect of the proximal segments, occlusal disharmony, and positional changes of the mandibular condyle and proximal segment.[6]

Adjustable plates have the advantage of decreasing operative time when occlusion is not perfect at the release stage and adjustments are required. Using the plate-specific pliers accompanying the kit, the joints can be either expanded or compressed to achieve the desired result. This allows anterior, posterior, clockwise and counter-clockwise directional change.

In the current study the age ranged between 22 and 27 years in order to avoid the effect of age on postoperative stability. ***Joss and Vasalli*** in their systematic review did not report post-surgical growth of the mandible after BSSO setback because the age was between 20 and 32 years.[7]

Data was aggregated in the form of mean and standard deviation (SD). 95% CI together with 0.05 P-value will be additionally reported. Data was analyzed using IBM SPSS advanced statistics (Statistical Package for Social Sciences), version 21 (SPSS Inc., Chicago, IL). The stability of mandibular position was described as mean and standard deviation. The Mann-Whitney U test was performed to test the significance between the 2 groups at each time period. Friedman's test followed by multiple comparisons test was performed to test the significance between the 4 time periods within each group. In addition, correction of p-value was done using Bonferroni adjustment to avoid hyperinflation of type 1 error that arises from multiple comparisons. A p-value ≤ 0.05 was considered statistically significant. All tests were two tailed.

For both groups F0-F1 was characterized by posterosuperior mandibular movement. This was accompanied by a decrease in SNB and MPA. Autorotation of the mandibular distal segment resulted during surgery and lead to superior movement of B point. For both groups, F1- F4 was characterized by anteroinferior mandibular movement.

Righi et.al and ***Fujioka et.al*** concluded a similar anteroinferior mandibular movement which took place during the follow-up period. They proposed that the "shearing force is the most noteworthy load affecting

the maxillomandibular system stability after osteotomy". In case of BSSRO, these "shearing stresses" act on the osteotomy site and causes clockwise rotation of the distal segment and counterclockwise rotation of the proximal segment.[8,9]

Lee et al reported that postsurgical skeletal changes after surgery-first approach BSSRO setback were also in the anterosuperior direction.[10] In contrast, ***Kim et al*** reported that changes were in the anteroinferior direction and they postulated that the possible reasons for this difference were mandibular counterclockwise rotation after surgical splint removal and differences of facial types among patients.[11]

Previous studies fixated on postoperative skeletal stability and the extent of relapse after BSSRO mandibular setback depending on fixation methods. ***Abeltins et al.*** stated that the mean (SD) horizontal relapse at B point was 1.4 mm.[12] ***Ballon et al.*** reported the point B point horizontal relapse was 1.05 mm.[13] ***Landes and Ballon*** reported that horizontal relapse at point B was 2.0 mm.[14] These authors all used four-hole sliding plates to fix the mandibular bony segments.

Rao et.al evaluated the skeletal stability after BSSO in advancement and setback cases using min iplates. In the setback group, mandibular plane had a statistically significant change position of 1.4 mm (paired t-test, $p = 0.03$). The SNB angle, remained constant during the follow-up period. In advancement cases, the relapse was seen from the third month postoperative period but in setback cases, the relapse was noted from the sixth month onward and the skeletal relapse in these cases were noticed cephalometrically.[15]

Hsu et.al evaluated mandibular prognathism stability corrected by BSSO comparing bi-cortical osteosynthesis and monocortical mini plates, the percentage of relapse in the mini plates group was 25%.[16] A reasonable explanation for the difference in mean mandibular relapse results is the length of the follow up period (6 months only).

Veyssiere's study on the preliminary effect of an adjustable S-shaped plate on 15 consecutive cases showed good results, with respect to the mechanical reliability of this plate for three months postoperatively corresponding to the bone-healing period. Radiographic observations did not show any significant displacement at the osteosynthesis site. Class III patients showed good clinical results without any occlusal relapse. From the radiographic study of this group, no patient has presented significant postoperative bone movements.[17]

In addition to time saving, the integrity of the bone at the site of fixation was preserved, instead of screws removal and re-drilling which could compromise the integrity of the bone. This is an additional comfort we have chosen to adopt in our study. Finally, the simplicity of the adjustment of these plates after centric relation check avoids any compromise in occlusion at the end of the surgery.

Other than our results, the choice of the fixation method should combine between sufficient stability for early jaw mobilization and elasticity to allow for intraoperative and early postoperative corrections. We think that the adjustable plates meet these criteria.

Funding

The study was self-funded

Competing interests

No conflict of interest

Ethical approval

The Ethics and research committee, Faculty of Dentistry, Cairo University approved the study and patients' consent was obtained.

References:

1. *Angle, E. L. Treatment of malocclusion of the teeth. Classification and Diagnosis of malocclusion (7thed.) 1907. http://doi.org/10.1017/CBO9781107415324.004*

2. *Ackerman, J. L., Proffit, W. R., & Sarver, D. M. The emerging soft tissue paradigm in orthodontic diagnosis and treatment planning. Clinical Orthodontics and Research 1999;2(2), 49–52 . http://doi.org/10.1111/ocr.1999.2.2.49*

3. *Bell WH, Scheideman GB. Correction of vertical maxillary deficiency:stability and soft tissue changes. J Oral Surg 1981;39:666.*

4. *Roh Y-C, Shin S-H, Kim S-S, Sandor GK, Kim Y-D. Skeletal stability and condylar position related to fixation method following mandibular setback with bilateral sagittal split ramus osteotomy. J Cranio-Maxillofacial Surg [Internet]. Elsevier Ltd; 2014;42(8):1958–63.*

5. Khechoyan DY. Orthognathic surgery: General considerations. Semin Plast Surg. 2013;27(3):133–6.

6. *Van Sickels, J. E., Larsen, A. J. & Thrash, W. J.: Relapse after rigid fixation of mandibular advancement. J. Oral Maxillofac. Surg. 1986: 44: 698-702.*

7. *Joss CU, Vassalli IM. Stability After Bilateral Sagittal Split Osteotomy Setback Surgery With Rigid Internal Fixation: A Systematic Review. J Oral Maxillofac Surg. 2008;66(8):1634–43.*

8. Righi, E., Carta, M., Bruzzone, A. A., Lonardo, P. M., Marinaro, E., & Pastorino, A. Experimental analysis of internal rigid fixation osteosynthesis performed with titanium bone screw and plate systems. JCraniomaxillofacSurg. 1996: 24(1), 53–57. doi:10.1016/s1010-5182(96)80078-3.

9. *Fujioka, M., Fujii, T., & Hirano, A. Comparative Study of Mandibular Stability After Sagittal Split Osteotomies: Biocortical Versus Monocortical Osteosynthesis. The Cleft Palate-Craniofacial J: 2000 37(6), 551–555. doi:10.1597/1545-1569(2000)037<0551.*

10. *Lee NK, Kim YK, Yun PY, Kim JW; J Craniomaxillofac Surg: 2013 41:47.*

11. *Kim CS, Lee SC, Kyung HM, et al: Stability of mandibular setback surgery with and without presurgical orthodontics. J Oral Maxillofac Surg: 2014 72:779.*

12. *Abeltins A, Jakobsone G,Urtane I, et al. The stability of bilateral sagittal ramus osteotomy and vertical ramus osteotomy after bimaxillary correction of class III malocclusion .JCraniomaxillofacSurg 2011;**39**:583–7.*

13. *Ballon A, Laudemann K, Sader R, etal. Segmental stability of resorbable P(L/DL)LA-TMC osteosynthesis versus titanium miniplates in orthognatic surgery.J CraniomaxillofacSurg 2012;**40**:e408–14.*

14. *Landes CA, Ballon A. Skeletal stability in bimaxillary orthognathic surgery :P(L/DL)LA-resorbable versus titanium osteofixation .Plast Reconstr Surg 2006;**118**:703–22.*

15. *Rao SH, Lankupalli AS, Selvaraj L. Skeletal Stability after Bilateral Sagittal Split Advancement and Setback Osteotomy of the Mandible with Miniplate Fixation. 2014;600077:9–15.*

16. *Hsu SSP, Huang CS, Chen PKT, Ko EWC, Chen YR. The stability of mandibular prognathism corrected by bilateral sagittal split osteotomies: A comparison of bi-cortical osteosynthesis and mono-cortical osteosynthesis. Int J Oral Maxillofac Surg. 2012;41(2):142–9.*

17. Veyssiere A, Leprovost N, Ambroise B, Prévost R, Chatellier A, Bénateau H. Study of the mechanical reliability of an S-shaped adjustable osteosynthesis plate for bilateral sagittal split osteotomies. Study on 15 consecutive cases. J Stomatol Oral Maxillofac Surg. 2018 Feb;119(1):19-24. doi: 10.1016/j.jormas.2017.11.003.