Stability of Condyle Position after Bilateral Sagittal Split Ramus Osteotomy Setback with Rigid Internal Fixation by 2 Screws Case Series

Farzin Sarkarat, Mohammad Hosein Kalantar Motamedi, Behnam Bohluli, Roozbeh Kahali, Yasaman Omrani and Zahra Nematollahi

Department of Oral and Maxillofacial Surgery, Buali Hospital, Azad University of Medical Sciences and Craniomaxillofacial Research Center IAU-Dental Branch Tehran, Iran

Introduction

Considering numerous cases of relapses after bilateral sagittal split ramus osteotomy (BSSRO) of the mandible and changes in the condylar position followed by the appearance of temporomandibular disorders, the aim of this study was to evaluate the effect of rigid internal fixation (RIF) with 2 screws on the stability of the condyle position after mandibular setback surgery using BSSRO.

Patients and methods

Twelve patients needing mandibular setback via BSSRO technique entered this study. The patient's undergone orthognathic surgery at Bouali hospital. Two transbuccal screws were used on each side of the mandible for fixation. The presence and/or absence of the TMD disorders, the aim of this study was to evaluate the effect of rigid internal fixation (RIF) with 2 screws on the stability of the condyle position after mandibular setback surgery using BSSRO.

Results

The study was conducted on 12 patients with mean age of 23±3.28 years (including 6 males and 6 females). The mean duration of follow up was 3.18±0.45months. Vertical and sagittal condylar position changes were less than 1 mm and not statistically significant (P>0.05). A statistically significant 15% and 16% increase of coronal medial space and coronal central space were observed respectively (P<0.05). There was no post-operative increase of TMD or fracture in patients.

Conclusion

Using rigid internal fixation technique with two screws on each side of the mandible following mandibular setback by using BSSRO technique makes no radiological changes of the vertical and sagittal condylar position but increases the coronal medial and central spaces between the condylar head and glenoid fossa.

Key words: Bone Screw; Internal Fixation; Mandibular Condyle; Maxillomandibular Fixation; Orthognathic Surgery; Skeletal Fixation

Abstract

Introduction

Trans oral Bilateral Sagittal Split Ramus Osteotomy (BSSRO) is a versatile technique for mandibular advancement/setback [1]. It has been performed routinely for correction of mandibular prognathism, retrognathism, anterior open bite or asymmetry [2]. Since its introduction by Obwegeser and Trauner in 1956 [3, 4], this procedure has undergone a number of modifications in attempts to improve the original method [3, 5, 6]. Those modifications came from a desire to make the procedure safer, more reliable, and more predictable with less relapse [7]. The reported overall relapse after BSSRO has ranged from 6% to 50% according to different surveys [2, 8, 16]. Displacement of the proximal segment upward and forward may take place when the periosteum is stripped completely of the lateral aspect of the ramus so that it may be moved freely. It may be combined with an occasional condylar dislocation, if the mouth is wide open. Improper manipulation of the segments after splitting of the ramus may contribute to this upward and forward movement. With meticulous performance of the operation and long-term maxillomandibular fixation, complications can be negligible, and relapse rates (the most problematic post-operative issue) can be significantly reduced [2]. Most previous reports have contrasted

Rec Date: November 21, 2015, Acc Date: December 7, 2015, Pub Date: December 9, 2015.

Citation: Farzin Sarkarat, Mohammad Hosein Kalantar Motamedi, Behnam Bohluli, Roozbeh Kahali, Yasaman Omrani and Zahra Nematollahi (2015) Stability of Condyle Position after Bilateral Sagittal Split Ramus Osteotomy Setback with Rigid Internal Fixation by 2 Screws Case Series. BAOJ Dentistry 1: 1004.

Copyright: © 2015 Farzin Sarkarat, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
the relapse rate between cases with rigid fixation and those treated with wire fixation and conventional maxillomandibular fixation (MMF) [17]. Bony stabilization has enhanced by using metal plates and screws and various combinations of both referred to as “rigid internal fixation” (RIF) instead of using wire osteosynthesis and maxillomandibular fixation (MMF) [18, 20]. Traditionally, the proximal and distal segments have been stabilized with wire osteosynthesis. In 1974, Spiessl introduced rigid fixation with osteosynthesis using lag screws [1, 16, 20]. Since then, several modifications have been presented including variations in the size and type of screws [1, 21] and bone plates [1].

RIF is commonly used after BSSRO of the mandible; however, there are few studies documenting its effect on condylar position. Tuinzing and Swart, studying dry mandibles, showed that intercondylar width decreased by using BSSRO for mandibular setback and increased when BSSRO used for mandibular advancement. Animal studies have been confirmed these findings by showing that RIF and maxillomandibular fixation combined with skeletal fixation are equally effective in the prevention of postsurgical relapse [22, 23]. Studies that have been done following the use of 2-mm bicortical screws for fixation of BSSRO used for mandibular advancement, have shown very stable results with little tendency for relapse [22, 24, 27]. This study was done to assess stability of condyle position after bilateral sagittal split ramus osteotomy setback with rigid internal fixation using 2 screws.

Patients and methods

Approval for this research was granted by Tehran Azad University of Dentistry [AU-300965]. This study was performed in the department of oral and maxillofacial surgery, Dental branch, Islamic Azad University, Tehran, Iran. Among patients aged [19,30], with indication for mandibular set back surgery who referred to the Buali hospital and a private clinic at Tehran, 12 patients with skeletal class III deformity, without skeletal asymmetry or temporomandibular joint disorder (TMD) were selected. Subjects provided informed consent for the protocol and related evaluations.

Clinical diagnostic criteria for TMD included Parafunctional habits (bruxism, clenching), orofacial pain, joint pain during palpations, clicking, limitation during mouth opening, mandibular shift during mouth opening, limitation during protrusion and lateral excursions. Patients having any of these criteria were excluded from the study.

All patients received pre-operative orthodontic treatment. During the surgery, no intentional overcorrection was done; the proximal segment was positioned experimentally and fixed with two trans-buccal bicortical positional screws; if there was any discrepancy of the dental occlusion from the pre-operative prepared surgical stent, the proximal segment was repositioned and fixed in its new position. At the end of the surgery the position of the mandibular condyles were confirmed after removing the intermaxillary fixation (IMF). After using post-surgical elastic traction therapy and surgical wafer, post-surgical orthodontics started about 3–4 weeks later and patients were followed for any sign or symptom of TMD.

Cone-beam computed tomography (CBCT) (ProMax 3D; Planmeca, Helsinki, Finland) images used to assess the condylar position before and 3 months after surgery. Device features were as follows; voxel size: 0.16 mm, Exposure time: 12 sec, Field of view: 8 × 8 cm, KVp: 80-84, mA: 10-12. Parameters measured in CBCT radiographs are as followed:

In the coronal plane (Figure 1), the true horizontal line (THL) was used as the standard plane. The widest mediolateral width of the condylar head which was parallel with the THL was identified and divided into six equal parts (two parts on the medial, two on the middle and two on the lateral side of the condylar head). The point between the two medial parts, between the two middle parts and between the two lateral parts was identified and their true vertical lines (TVL) (perpendicular to the THL) extended to the outer surface of condylar head. The contact points of the medial, middle and lateral TVLs with the condylar head surface were termed as CM (coronal medial), CC (coronal central) and CL (coronal lateral) points respectively. In our study we used linear measurements of joint space from CM, CC, and CL to the roof of the glenoid fossa were measured as the shortest
In the sagittal plane (Figure 3), the sagittal reference line (L1) was drawn from the most inferior point of the articular eminence (P1) to the superior tip of the porion (P2). Condylar head base line (L3) was constructed between the points of inflection of condylar head (P5 and P6). Condylar head line (L2) was drawn from the most superior point of the condylar head (P3) to the midpoint (P7) of L3. P4 is the intersecting point between L1 and L2. Sagittal condylar head long-axis angle (SHA) is the anterior-inferior angle between sagittal reference line (L1) and condylar head line (L2). Superior-inferior condylar position (SI) is the shortest distance between the P3 and L1. Antero-posterior condylar position (AP) is the shortest distance between P4 and P2.

The data were analyzed by SPSS software version 18 using paired t-test statistical analysis.

Results

The ages ranged from 19 to 30 years, with an average of 23±3.28 years. The average follow-up period was 3.18±0.45 months. Clinical diagnostic criteria of temporomandibular joint (TMJ) were studied preoperatively and 3 months postoperatively. The mean values and the standard deviations (SD) for all of the eight cephalometric measurements of this study (SI, AP, SHA, AMS, ALS, CLS, CMS, CCS) subjected to the paired t-test are presented in [Table 1].

Condylar position changes (SI, AP) were less than 1 mm with no
significant changes (P>0.05). At the time of the follow-up there was an increased mean advancement of 15% in CMS (P<0.05) and 16% in CCS (P <0.05) which were statistically significant. In none of the patients did temporomandibular disorder (TMD) increase. According to the presence of the preoperative TMD, distribution of the postsurgical TMD is presented in [Table 2]. The patients with no preoperative TMD (n=6) showed no postsurgical changes, but in cases with preoperative TMD (n=6), 5 patients showed postsurgical improvement of the TMD symptoms and one remained unchanged; which was statistically significant (Fisher’s test, P< 0.08).

**Discussion**

In our study, due to the skill of the surgeons and in the knowing that clockwise rotation of proximal segment is the most important factor associated with the relapse, proximal segment rotations were prevented by using myotomy in conjunction with using 2 transbuccal bicortical screws in order to provide greater stability for RIF. Average Changes of the condylar position following BSSRO with two screws fixation were less than 0.5 mm, and almost never more than 1mm. CCS, CMS and AP changes were in the physiological range. This condylar position change keeps the joint space open and the joint disc moves more freely than before. TMD symptoms improved in 5 cases and showed no changes in 1 case. Watzke et al reviewed the relationship between rigid internal fixation (RIF) and Wire Fixation in 70 patients with indications for mandibular advancement, they concluded that in patients with RIF, the vertical and horizontal position of the segments were more stable in the first six weeks after surgery, while patients who received Wire Fixation showed an improvement at 6 weeks up to one year [18]. Will et al evaluated 41 patients who underwent BSSRO and Wire osteosynthesis; they found increased clockwise inclination of the distal segment and upward movement of the proximal segment during the fixation period [28]. In 2009 Ueki et al assessed changes of the temporomandibular joint morphology and its clinical features after BSSRO with or without Le Fort osteotomy in 45 Japanese patients with mandibular prognatism. Mini plates and monocortical screws were used for fixation. Evaluation of TMJ symptoms and joint morphology was down by MRI and axial cephalometric radiographs 1 month before and 6 months after the operation. There were significant differences before and after surgery in the BSSRO group. There were no significant differences between the BSSRO group and BSSRO & Le Fort I group. The preoperative condylar position did not change in any of the groups. These results suggest that BSSRO with or without Le Fort I could not change preoperative condylar position or correct the anterior displacement of the disc [29]. Our research showed that the use of the two screws RIF technique in mandibular set back has a positive clinical effect on condyle position and significantly affected the CMS and CCS indexes.

Although condylar positional change is a concern for many physicians but some motions are better, for example anterior movement is better than the posterior one because, posterior movement is a major factor in the TMJ disorders [30, 31]. Severe downward displacement of condyle and increased radiographic joint space demonstrates the presence of blood or fluid in the

| Measurement | Preoperative Mean (SD) | Postoperative Mean (SD) | Changes (%) | P-value |
|-------------|------------------------|-------------------------|-------------|---------|
| SI          | 2.64 mm (1.05)         | 2.72mm (0.98)           | 3.0         | 0.546   |
| AP          | 14.28 mm (1.48)        | 15.08mm (1.73)          | 5.6         | 0.058   |
| AMS         | 2.00mm (0.53)          | 2.18 mm (0.91)          | 9.0         | 0.500   |
| ALS         | 1.80mm (0.93)          | 1.55 mm (0.68)          | -16.1       | 0.297   |
| CLS         | 1.39 mm (0.70)         | 1.56 mm (0.65)          | 12.2        | 0.401   |
| CMS         | 1.81 mm (0.58)         | 2.09 mm (0.77)          | 15.4        | 0.045   |
| CCS         | 1.85 mm (0.59)         | 2.15 mm (0.65)          | 16.2        | 0.029   |
| SHA         | 91.25° (10.16)         | 91.94 ° (9.60)          | 0.7         | 0.626   |

SI: Superior Inferior Condylar Position
AP: Anterior Posterior Condylar Position
AMS: Axial Medial Space
ALS: Axial Lateral Space
CLS: Coronal Lateral Space
CMS: Coronal Medial Space
CCS: Coronal Central Space
SHA: Sagittal Condylar Head Long Axis Angle
space. The severe reduction in the width or the loss of joint space could indicate the displacement, perforation or loss of soft tissue inside the capsule [32].

In 2006 Baek et al compared the condylar position and angulation on 3-dimensional (3D) views between greater setback side (GSS) and lesser setback side (LSS) after asymmetric mandibular setback (AMS) using computed tomography 1 month before and 6 months after surgery in 12 patients who underwent BSSRO with rigid fixation with 4 positional screws. As a result, there were significant inward and backward rotations of the condylar head in GSS and significant backward rotation in LSS [33]. In our study, condylar position changes wherein the anterior-lateral-inferior direction. Their sample size was as same as our study but using CBCT instead of the CT would be more accurate. According to the CT, margins of the joint structures were unclear due to large slice thickness ranging between 1.0 and 3.0mm. To take coronal images by conventional tomography, the patient had to be positioned in the machine with the mouth open and the head tilted up. Today, CBCT devices provide higher pixel resolutions of the images [32].

It has been suggested that clamp placement and subsequent screw fixation probably have more influence on the condylar displacement than the direction or the amount of surgical movement [33]. BongHae Cho et al compared the changes of the condylar axis, the antero-posterior condylar position relative to the glenoid fossa, and 2-jaw-surgery post operative stability with CBCT in 26 skeletal cl III patients. 3 positional screws were used for BSSRO rigid fixation. All patients were assessed by cone-beam computerized tomography (CBCT) before and after surgery. As the result of the anterior-posterior condylar position in the glenoid fossa, in the long-term follow up there was a condylar tendency to return toward its original position, which did not negatively affect the stability. According to the study of TMD symptoms, there were some relapses in the long term due to physiological adaptations which caused some instability and intensified TMD symptoms [34].

Wang et al studied the changes in temporomandibular joint function and condylar position after mandibular setback using different rami osteotomies in 50 patients with mandibular prognathism. Twenty-two patients underwent BSSRO technique and miniplates and monocortical screws were used for the rigid fixation. In the BSSRO group, the TMJ radiographs showed a posterior displacement of the condyle [35]. Probably, the difference between our results with the mentioned study was because of the fixation technique, magnitude of setback, condylar sag, osteotomy slippage, direction or amount of surgical movement and control of the proximal segment. In our study, CMS, CCS and AP radiographic indexes have more diagnostic values. Our results are similar to the results of Beak and Jason Joseph Alexan's studies. In Beak’s study, other indexes such as frontal head angle (FHA), frontal neck angle (FNA), axial head angle (AHA) and axial condylar axis angle (ACA) were also used. (33) In Joseph Aleman’s study, inter condylar angle index was also evaluated [36].

BSSRO with 2 screws rigid fixation and post-up orthodontic treatment seems to remove the stress from the joints, which leads to the improvement of clinical signs of TMD. Since CCS, CMS and AP showed greater credibility; perhaps by combining these indexes with other diagnostic indexes, better results could be achieved.

**Conclusion**

In this study it was concluded that the position of the condyle is affected by 2 screws rigid fixation technique in patients who underwent mandibular set back with BSSRO techniques by influencing the CMS, CCS and AP indexes. These changes had positive effect on TMD symptoms and it is suggested to use 2-screws rigid fixation technique following mandibular set back with BSSRO technique.

**References**

1. Nishioka GJ, Zysset MK, Van Sickels JE (1987) Neurosensory disturbance with rigid fixation of the bilateral sagittal split osteotomy. Journal of Oral and Maxillofacial Surgery 45(1): 20-26.
2. Martis CS (1984) Complications after mandibular sagittal split osteotomy. Journal of Oral and Maxillofacial Surgery 42(2): 101-107.
3. Abeloos J, De Clercq C, Neyt L (1993) Skeletal stability following miniplate fixation after bilateral sagittal split osteotomy for mandibular advancement. Journal of Oral and Maxillofacial Surgery 51(4): 366-369.
4. Trauner R, Obwegeser H (1957) The surgical correction of mandibular prognathism and retrognathia with consideration of genioplasty: Part I. Surgical procedures to correct mandibular prognathism and reshaping of the chin. Oral Surgery, Oral Medicine, Oral Pathology 10(7): 677-689.
5. Dal P (1961) Retromolar osteotomy for the correction of prognathism. J Oral Surg 19: 42-47.
6. Epker B (1977) Modification in the sagittal osteotomy of the mandible. J Oral Surg 35: 157-159.
7. Monson LA (2013) Bilateral Sagittal Split Osteotomy. Seminars in Plastic Surgery. Thieme Medical Publishers 27(3): 145–148.
8. Freihofer HPM, Petreševié D (1975) Late results after advancing the mandible by sagittal splitting of the rami. Journal of maxillofacial surgery 3: 250-257.
9. Peipersack WJ, Chausse JM (1978) Long term follow-up of the sagittal splitting technique for correction of mandibular prognathism. Journal of maxillofacial surgery 6: 117-139.
10. MacIntosh RB (1981) Experience with the sagittal osteotomy of the mandibular ramus: a 13-year review. Journal of maxillofacial surgery 9: 151-165.
11. Egyedi P (1965) Evaluation of operations for mandibular protrusion. Oral Surgery, Oral Medicine, Oral Pathology 19(4): 451-458.
12. Cook RM, Hinrichsen G (1973) The mandibular sagittal split osteotomy—a clinical and cephalometric review. Transactions of the International Conference on Oral Surgery 4: 232-236.

13. Vijayaraghavan K, Richardson A, Whitlock R (1974) Post-operative relapse following sagittal split osteotomy. British Journal of Oral Surgery 12(1): 63-69.

14. Freihofer HPM (1977) Results of osteotomies of the facial skeleton in adolescence. Journal of maxillofacial surgery 5: 267-297.

15. Broadbent Tr, Woolf Rm (1977) Our Experience With Sagittal, Split Osteotomy for Retrognathia. Plastic and reconstructive surgery 60(6): 860-867.

16. Souyris F (1978) Sagittal splitting and bicortical screw fixation of the ascending ramus. Journal of maxillofacial surgery 6: 198-203.

17. Blomqvist JE, Ahlberg G, Isaksson S, Svartz K (1997) A comparison of skeletal stability after mandibular advancement and use of two rigid internal fixation techniques. Journal of Oral and Maxillofacial Surgery 55(6): 568-574.

18. Erkmen E, Şimşek B, Yücel E, Kurt A (2005) Comparison of different fixation methods following sagittal split ramus osteotomies using three-dimensional finite elements analysis: Part 1: advancement surgery-posterior loading. International journal of oral and maxillofacial surgery 34(5): 551-558.

19. Edwards RC, Kiely KD, Eppley BL (2001) Fixation of bimaxillary osteotomies with resorbable plates and screws: experience in 20 consecutive cases. Journal of Oral and Maxillofacial Surgery 59(3): 271-275.

20. Wall G, Rosenquist B (2001) Radiographic stereophotogrammetric evaluation of intersegmental stability after mandibular sagittal split osteotomy and rigid fixation. Journal of Oral and Maxillofacial Surgery 59(12): 1427-1435.

21. Jeter TS, Van Sickels JE, Dolwick MF (1984) Modified techniques for internal fixation of sagittal ramus osteotomies. Journal of Oral and Maxillofacial Surgery 42(4): 270-272.

22. Gassmann CJ, Van Sickels JE, Thrash WJ (1990) Causes, location, and timing of relapse following rigid fixation after mandibular advancement. Journal of Oral and Maxillofacial Surgery 48(5): 450-454.

23. Ellis III E, Reynolds S, Carlson DS (1988) Stability of the mandible following advancement: a comparison of three postsurgical fixation techniques. American Journal of Orthodontics and Dentofacial Orthopedics 94(1): 38-49.

24. Van Sickels JE, Flanary CM (1985) Stability associated with mandibular advancement treated by rigid osseous fixation. Journal of Oral and Maxillofacial Surgery 43(5): 338-341.

25. Van Sickels JE, Larsen AJ, Thrash WJ (1986) Relapse after rigid fixation of mandibular advancement. Journal of Oral and Maxillofacial Surgery 44(9): 703-707.

26. Kirkpatrick T, Woods M, Swift J, Markowitz N (1987) Skeletal stability following mandibular advancement and rigid fixation. Journal of Oral and Maxillofacial Surgery 45(7): 572-576.

27. Van Sickels JE, Larsen AJ, Thrash WJ (1988) A retrospective study of relapse in rigidly fixated sagittal split osteotomies: contributing factors. American Journal of Orthodontics and Dentofacial Orthopedics 93(5): 413-418.

28. Will LA, Joonodeph DR, Hohl TH, West RA (1984) Condylar position following mandibular advancement: its relationship to relapse. J Oral Maxillofac Surg 42: 578-588.

29. Ueki K, Marukawa K, Shindma M, Hashiba Y, Nakgawa K, et al. (2009) Condylar and disc positions after sagittal split ramus osteotomy with and without Le Fort osteotomy. Int J Oral Maxillofac Surg 38(7): 726-730.

30. Rotskoff KS, Herbsa EGe, Villa P (1991) Maintenance of condyle proximal segment position in Orthognathic surgery. J Oral proximal Maxillofac Surg 49:2

31. Katzberg RW, Keith DA, Ten Eick WR (1983) Internal derangements of the temporomandibular joint: An assessment of condylar position in centric relation. J Prosthet Dent 49: 250.

32. Fatemeh Ezoddini-Ardakani (2011) Principles of inter pretation of Oral and Maxillofacial radiology 182-244.

33. Baek SH, Kim MJ (2006) Is there any difference in the condylar position and angulation after asymmetric mandibular setback? Oral Surg Oral Med Oral Pathol Oral Radiol Endod 101(2): 155-163.

34. Yong-Il Kim, Bong-Hae Cho, Yun-Hoa Jung, Woo-Sung Son, Soo-Byling Park, et al. (2011) Cone-beam computerized tomography evaluation of condylar changes and stability following two-jaw surgery: Le Fort I osteotomy and mandibular setback surgery with rigid fixation. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontontology 111 (6): 681-687.

35. Liu A, Zhang Z, Wang X (2000) The effect of orthognathic surgery on temporomandibular joint function. Zhonghua Kou Qiang Yi Xue ZaZhi 35(2): 135-137.

36. Jason josep Alemán (1994) Assessment of postsurgical condylar position following bimaxillary advancement osteotomy: an analysis using cone-beam computed tomography (CBCT). Department of Orthodontics, University of Detroit Mercy, School of Dentistry, Michigan.The International journal of adult orthodontics and Orthognathic surgery 9(1): 55-56.