Abstract

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 orthognathicsurgery at Bouali hospital. Two transbuccal screws were used on each side of the mandible for fixation. The presence and/or absence of the TMD was evaluated pre-operatively and 3-months post-operatively through clinical examinations and cone-bam computed tomography (CBCT). T-test was used for data analysis (P value was set at 0.05).

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

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 the reported relapse rates.

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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 biocortical 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 transcortical 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. On the coronal cross-sectional image 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) 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
distances from the respective points to the surface of the roof of the glenoid fossa and termed it as coronal medial space (CMS), coronal central space (CCS), and coronal lateral space (CLS). Based on the selection criteria; skeletal class III malocclusion patients with mandibular prognathism (Pog to N perpendicular > 5.0 mm, ANB < 0, A to N perpendicular <1.0 mm) and facial symmetry, 12 patients (6 females and 6 males) were assessed.

In the axial plane (Figure 2), The distances from the medial pole (axial medial point: AM) and the lateral pole (axial lateral point: AL) of the condylar head were measured to the medial and lateral walls of the glenoid fossa along an imaginary line extending from the widest mediolateral portion of the condylar head and termed as axial medial space (AMS) and axial lateral space (ALS), respectively.

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 1 mm. 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 done 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

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

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

**Table 2:** Distribution of pre- and postoperative temporomandibular disorder

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Improvement</th>
<th>No change</th>
</tr>
</thead>
<tbody>
<tr>
<td>n₁=6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>n₂=6</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

n₁: without preoperative TMD n₂: with preoperative TMD
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 class 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 ramus 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 Aleman'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**


