Surgical Correction of Asymmetric Mandibular Prognathism with Modified Bilateral Sagittal Split Osteotomy Technique: A Clinical Study

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Abstract

Introduction: An asymmetrical face consists of multitude of the minor asymmetrical component, the mandibular component being most common. The asymmetric mandibular prognathism (AMP) is one of the most common forms of asymmetry caused by genetic and epigenetic factors and environmental condition such as trauma, functional deviations due to dental interference. The present study was undertaken to assess the efficacy of a modified bilateral sagittal split osteotomy (BSSO) technique in correction of AMP.

Purpose: The purpose of the study was to investigate the skeletal stability and changes of proximal segments position post-operatively following surgical correction of AMP with modified BSSO technique and analyze the effect of such changes on the incidence of signs and symptoms of temporomandibular joint (TMJ) disorders.

Materials and Methods: Patients with AMP were included in the study. All the patients underwent surgical correction by modified BSSO technique. The patient clinical and cephalometric findings (pre-operative, immediate post-operative, and 6 months post-operatively) were recorded in a proforma and subjected to statistical analysis.

Results: A total of six (n = 6) participated in the study. Five out six patients had pre-existing TMJ problems. In lateral cephalogram, the mean mandibular setback of Point B was 7.75 mm. In frontal cephalogram, the mean mandibular deviation decreased 2.55 mm after surgery. Minimal relapse was noted 6 months post-operatively suggestive of good skeletal stability with minimal complications.

Conclusions: The modified BSSO technique was effective in the treatment of AMP.

Keywords: Cephalometry, Facial asymmetry, Mandibular, Prognathism, Temporomandibular joint

INTRODUCTION

Variations in the size, shape, and relationship of the dental, skeletal, and soft tissue facial structures are important in providing each individual with his or her own identity. The point at which “normal” asymmetry becomes “abnormal” cannot be easily defined and is often determined by the clinician’s sense of balance and patient’s perception of the imbalance.1

The asymmetric Class III mandibular prognathism or deviate mandibular prognathism is one of the most common forms of asymmetry affecting the maxillofacial skeleton. Bilateral sagittal split osteotomy (BSSO) and intraoral vertical ramus osteotomy are currently the most preferred methods for correction of this condition. While there is little doubt about the usefulness of BSSO in the conventional mandibular setback, its role in asymmetric mandibular setback (AMS) is still a matter of controversy.

A large number of patients with asymmetric mandibular prognathism (AMP) often have associated temporomandibular joint internal derangements (TMJ-ID).2 AMS by BSSO can cause a different change in condylar position and angulation in the greater setback size (GSS) and lesser setback side (LSS) due to rotation of mandible into GSS which in turn may lead to relapse.
and/or increase TMJ problems. Second, AMS will result in some flaring of the proximal mandibular ramus on the LSS. When such flaring is present to an appreciable extent and is not corrected, it results in a long-term, clinically obvious asymmetry of the mandibular angle ramus area. 

The present study was undertaken to assess the efficacy of a modified BSSO technique in AMS with reference to post-operative mandibular stability and to investigate the changes of proximal segment position.

**MATERIALS AND METHODS**

Six patients with AMP participated in the study which was conducted in the Department of Oral and Maxillofacial Surgery, Buddha Institute of Dental Sciences and Hospital, Patna between 2009 and 2013. The patient with severe occlusal cant or progressive asymmetry suggesting of a patent growth center in condyle were excluded from the study. No case of cleft palate or other craniofacial syndromes were included in the study.

**Surgical Technique**

All the patients were operated by the same surgeon using the BSSO technique with Dalpont–Hunsuck–Epker modification. Following completion of split on both sides, the mandible was completely mobilized. To prevent flaring of the proximal ramus segment on the deviated side, i.e., LSS, distal osteotomy procedure was performed. Care was taken to protect the lingula and inferior alveolar nerve and lingual nerve. The posterior portion of the distal fragment was then green stick fractured medially with a bone holding forceps. The distal fragment was rotated and positioned posteriorly in proper position and secured to maxilla with splints and intermaxillary fixation (IMF). The proximal portion was then stabilized with the distal fragment with the help of 2 mm (4 hole plate) miniplate and monocortical screws after removing bony interference, if any and ascertaining the correct position of condyle by mechanical manipulation. Semi-rigid fixation with miniplates was preferred over rigid fixation to prevent excess stress on the proximal segment, especially in view of pre-existing TMJ disorders in a majority of patients.

**Cephalometric Measurement for Skeletal Stability**

The changes in mandibular position were evaluated on lateral and frontal cephalogram which were obtained with vertically adjustable head holders. All cephalograms were taken with the patient’s teeth in intercuspal position and traced by the same researcher. Cephalograms were taken just before surgery (T1), 2 TO 3 days after surgery (T2), and at the beginning of retention period (over 6 months after the operation, T3) and were superimposed according to pre-specified reference lines as mentioned below. Table 1 shows the cephalometric measurements used in this study.

**Lateral cephalometric measurements**

The reference points, nasion (N), porion (Po), and sella (S) were determined. The Frankfort horizontal line through porion (Po) and orbitale (Or) were used as the Y-axis. The mandibular plane was defined as the line between (Go) and menton (Me). The following variables were measured: Overbite, overjet, mandibular plane angle (SN-MeGo), and SNB angle. The projection on the X-axis of the displacement of Point B between T1 and T2, and T2 and T3 was used to measure the surgical and the post-operative movements (Figure 1).

**Frontal cephalometric measurements**

The intersection of the lateral orbital wall with greater wing of sphenoid (Lo and Lo’) was marked. The reference Point C, i.e., the midpoint of the line joining Lo and Lo’ was marked. C represented the frontal midline. The perpendicular distance between the menton (Me) to the frontal midline was represented as the mandibular deviation (MD) (Figure 2).

**RESULTS**

Table 2 shows the demographic, intra operative, and pre- and post-operative clinical findings. The mean age
was 21.1 years with a range from 19 to 24 years. The male:female ratio was 1:1 (3:3). In five out of six patients, the chief complaint was mainly esthetic while one patient reported to our department because of the TMJ problems. Five out of six patients had pre-existing signs and symptoms of TMJ problems such as clicking and/or pain. Four of these five patients had their TMJ problems corrected following surgery. In four out of six patients, the mandible was deviated toward the left side while in two patients the mandible was deviated to the right side.

**Table 1: Cephalometric measurements used in the study**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Mandibular deviation side</th>
<th>Difference in mandibular setback (mm)</th>
<th>IMF (days)</th>
<th>TMJ sounds</th>
<th>TMJ pain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Right</td>
<td>Left</td>
<td></td>
<td>Pre-operative</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>Left</td>
<td>9.6</td>
<td>8.4</td>
<td>20</td>
<td>+</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>Left</td>
<td>6.6</td>
<td>5.2</td>
<td>21</td>
<td>−</td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>Left</td>
<td>7.6</td>
<td>6.2</td>
<td>23</td>
<td>+</td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>Right</td>
<td>7.5</td>
<td>6.7</td>
<td>21</td>
<td>+</td>
</tr>
<tr>
<td>Male</td>
<td>19</td>
<td>Left</td>
<td>10.2</td>
<td>9.1</td>
<td>21</td>
<td>+</td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>Right</td>
<td>8.2</td>
<td>7.3</td>
<td>21</td>
<td>+</td>
</tr>
</tbody>
</table>

**Table 2: Demographic, clinical, pre-operative, and post-operative findings**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Pre-operative (T1)</th>
<th>Post-operative</th>
<th>Beginning of retention (T3)</th>
<th>Surgical changes (T2-T1)</th>
<th>Post-operative changes (T3-T2)</th>
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<tr>
<td>Lateral cephalogram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNB (°)</td>
<td>88.67±3.52</td>
<td>80.53±2.47</td>
<td>81.63±1.99</td>
<td>8.13±1.39</td>
<td>1.10±0.68</td>
</tr>
<tr>
<td>SN-MeGo (°)</td>
<td>32.88±3.11</td>
<td>36.51±2.64</td>
<td>37.43±2.46</td>
<td>3.62±0.79</td>
<td>0.95±0.74</td>
</tr>
<tr>
<td>Overbite (mm)</td>
<td>−1.28±0.58</td>
<td>1.78±0.69</td>
<td>1.50±0.75</td>
<td>3.07±0.96</td>
<td>−0.28±0.22</td>
</tr>
<tr>
<td>Over jet (mm)</td>
<td>−2.31±0.72</td>
<td>1.13±0.61</td>
<td>1.01±0.53</td>
<td>3.43±1.24</td>
<td>−0.25±0.22</td>
</tr>
<tr>
<td>Posterior mandibular movement (mm)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>7.75±1.32</td>
<td>0.33±0.19</td>
</tr>
<tr>
<td>Frontal cephalogram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular deviation (mm)</td>
<td>3.58±1.45</td>
<td>1.03±0.74</td>
<td>1.31±0.72</td>
<td>−2.55±0.86</td>
<td>−0.27±0.16</td>
</tr>
</tbody>
</table>

**Figure 2:** Planes and landmarks in frontal cephalogram, Lo, Lo’:
The intersection of right and left orbital margins with greater wing of sphenoid, LOL: The line joining Lo and Lo’, C: Mid point on LOL’, M: Line through C and perpendicular to LOL, Me: Menton

The mean mandibular setback on the right and left side were 8.2 mm and 7.1 mm, respectively. The duration of IMF varied from 20 to 23 days with a mean of 21.1 days.

**Cephalometric Findings**
Lateral and frontal cephalograms were taken pre-operatively (T1), immediate post-operative period (T2), and approximately 6 months post-operatively (T3).

**Surgical Changes (T1-T2)**
Table 3 shows the findings on lateral and frontal cephalogram. Charts 1 and 2 show surgical changes...
in lateral and frontal cephalograms. In the lateral
cephalograms, the mean mandibular setback of Point B
was 7.75 cm, the mean SNB decreased from 88.67° to
80.53° during surgery. The mandibular plane rotated
clockwise, as indicated by the mean 3.62° change. The
mean changes in overbite and overjet were 3.07 mm and
3.43 mm, respectively. In the frontal cephalogram, the
mean MD decreased 2.55 mm after surgery.

**Post-operative Changes (T2-T3)**
The post-operative changes are shown in Charts 3 and 4.
The surgical and post-operative changes are compared in
Charts 5 and 6.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral cephalogram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SNB (°)</td>
<td>T2</td>
<td>80.53</td>
<td>2.47</td>
<td>-0.849</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>81.63</td>
<td>1.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN-MeGo (°)</td>
<td>T2</td>
<td>36.50</td>
<td>2.64</td>
<td>-0.633</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>37.43</td>
<td>2.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overbite (mm)</td>
<td>T2</td>
<td>1.78</td>
<td>0.70</td>
<td>0.676</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>1.50</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over jet (mm)</td>
<td>T2</td>
<td>1.13</td>
<td>0.60</td>
<td>0.407</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>1.00</td>
<td>0.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frontal cephalogram</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandibular deviation (mm)</td>
<td>T2</td>
<td>1.03</td>
<td>0.74</td>
<td>-0.636</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td></td>
<td>T3</td>
<td>1.00</td>
<td>0.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SD: Standard deviation

In the lateral cephalogram, the mean post skeletal relapse
in the SNB and SN-MeGo plane angles were 1.10° and
0.95°, respectively. The most post-operative relapse in
overbite and overjet were 0.28 and 0.25 mm, respectively.
The mean post-operative relapse in Point B was 0.33 mm
anteriorly. In the frontal cephalogram, the mean post-
operative horizontal relapse in MD was 0.27 mm. The
Student’s t-test was used to compare parameters in T2
and T3. None of the parameters measured were found
to statistically significant (Table 4).
Cephalometric Analysis for Proximal Segment Position

Measurement of the amount of proximal segment displacement on the short side showed an average 1.25° difference between pre-operative conditions (Table 4). The largest angle measured was 2.5°, and the smallest angle was 0.5°. Post-operative radiographs showed no abnormal position of the condyle.

Complications

Out of 6 operated patients, i.e., 12 operated sites, paraesthesia was noted in 4 sites. The paraesthesia gradually resolved in 3 of the 4 operative sites.

DISCUSSION

AMP accounts for 70-80% of all skeletal class 111 skeletal deformities. Deviations to the left side are more common than right. There is a strong correlation between mandibular asymmetry and unilateral degenerative joint disease. In fact, many authors consider TMJ-ID as a potential etiological factor for AMP.

In our study, 5 of the 6 patients showed signs and symptoms of TMJ-ID in the form of TMJ click. One patient has both TMJ pain and clicks in the pre-operative period.

The improvement in the signs and symptoms of TMJ following BSSO has been widely debated. Some studies showed remarkable improvements in pre-existing TMJ disorders following BSSO with rigid fixation. On the contrary, some studies have reported increased TMJ problems following BSSO. In our study, 80% of the patients reported improvement in signs and symptoms of TMJ disorder.

Position of Proximal Segment

The degree of proximal segment rotation during surgery, whether forward or backward, is associated with short-term instability. Moreover, change in condylar position is one of the most common reasons for the short-term relapse of orthognathic surgery cases. In our study, the amount of proximal segment displacement on the short side showed an average 1.25° ± 0.88° difference between pre- and post-operative condition. These findings along with the relief of TMJ symptoms in the majority of patients shows that any discrepancy in condylar position produced was well within the range of tolerable condylar rotation.

Skeletal Stability

Proffit et al. ranked isolated mandibular setback as the third least stable orthognathic surgical movement after maxillary inferior repositioning and transverse maxillary expansion. Horizontal relapse is more common than vertical relapse and has been attributed to no. of factors such as the amount of setback, fixation techniques, the position of condyle, and forward displacement of pterygomasseteric sling. There are varying reports in the literature about relapse following BSSO and mandibular setback with varying periods of follow-up.

In our study, the mean post-operative relapse noted at Point B was 0.33 mm anteriorly and 0.27 mm for MD, and the mean vertical relapse was 0.95° (SN-MeGo). In AMS when BSSO is done on the deviated side, the proximal bone segment is pushed aside by posterior border of the displaced distal bone segments, which may lead to a post-operative mandibular relapse. In our study, following BSSO the posterior part of the distal segment was osteotomized and green stick fractured to prevent

| Table 4: Cephalometric changes in measurement measurements |
|----------------|----------------|
| Angular lateral cephalometric measurements | SNB angle (SNB) |
| S-N-B | SNB angle (SNB) |
| SN-mego | SNB angle (SNB) |
| Linear lateral cephalometric measurements | Vertical overlap of central incisors |
| Overbite | Overjet |
| PMM | Horizontal line from Point B to the line through sella perpendicular to FH plane |
| Linear anteroposterior cephalometric measurements | ME-M (deviation is positive on deviated side) |
| Mandibular deviation | ME-M (deviation is positive on deviated side) |
| Changes in measurement | Post-operative measurements, T2 - pre-operative measurements, T1 |
| Surgical changes | Measurement at the beginning of retention, T3 - post-operative measurements, T2 |
| Post-operative change | |

PMM: Posterior mandibular movement, MD: Mandibular deviation
interference with the proper positioning of proximal fragment. This result assumes significance as some recent studies suggest that in BSSO there is the greatest interference between the proximal and distal segments of the mandibles as compared to other surgical techniques such as intra oral vertical ramus osteotomy and short lingual osteotomy.22

Kobyashi et al. suggested significant anterior relapse potential might exist when the amount of correction exceeded 10 mm in BSSO with miniplates.19 In our study, the mean mandibular setback was only 7.75 cm. This factor along with the modification of BSSO as described might significantly contribute to low relapse in our study.

Complications
The reported neurosensory disturbance following BSSO has been from 22% to 100%.23 The incidence of neurosensory disturbance and bad split were 33.3% and 0.8% which was on the lower side. Besides no other complications as mentioned in literature, such as non-union, infection, hemorrhage, and facial nerve injury, were encountered.

CONCLUSION
This study was conducted to evaluate the efficacy of modified BSSO technique in the management of AMP. An attempt was made to analyze the proximal segment positioning and skeletal stability following this procedure. Other parameters, such as TMJ signs and symptoms and complication of this procedure, were also studied. The conclusion drawn from the study is that BSSO can be effectively used to treat patients with asymmetric prognathism with pre-existing TMJ disorders. The post-operative skeletal stability was good with minimal relapse for the time period followed. However, the study has some draw backs which include small sample size. In future, similar studies with large sample size should be undertaken to arrive at a more definitive conclusion. Besides a comparative study with other osteotomy techniques such as intra oral vertical ramus osteotomy is also advocated.

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