Skeletal Relapse After Mandibular Setback in Bi Max Surgery: Intraoral Vertical Ramus versus Bilateral Sagittal Split Osteotomies

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Abstract

Objectives This study aimed to measure and compare the postoperative horizontal and vertical changes (relapse) that occur at B point and pogonion after intraoral vertical ramus osteotomy (IVRO) without fixation and bilateral sagittal split osteotomy (BSSO) with semi rigid internal fixation in bimax surgery.

Materials and Methods Eleven patients with skeletal class III malocclusion mandibular prognathism and maxillary hypoplasia were chosen. Six cases underwent BSSO; and five IVRO. All patients underwent Lefort I osteotomy without genioplasty.

Result Postoperative changes (relapse) of B-point and pogonion in horizontal and vertical axes from 1 week post operatively (T0) to 1 year post operatively (T2) were assessed and the percentage of relapse of each point and each axis was compared. It was noted that the horizontal relapse in IVRO was 27.7 % at B point and 40.6 % at pogonion while, in BSSO group it was noted that the horizontal relapse was 28.1 % at B point and a greater number i.e., 40.9 % at pogonion.

Conclusion The percentage of horizontal relapse after IVRO without fixation is equal to that after BSSO with semi rigid internal fixation.

Keywords Relapse · B point · Pogonion · Vertical ramus osteotomy (IVRO) · Bilateral sagittal split osteotomy (BSSO)

Introduction

People today usually recognize irregular teeth or obvious jaw deformities and seek treatment from an orthodontist to improve tooth alignment, function, and facial esthetics. More severe deformities that require a combination of orthodontics and surgery for correction are called dentofacial deformities. The combination of surgery and orthodontic treatment makes it possible to treat dentofacial deformities that could not have been corrected orthodontically [1].

The most common orthognathic procedure is a bilateral sagittal split ramus osteotomy (BSSO) to setback or advance the mandible. From a surgeon's point of view, long-term stability following BSSO may be the most important thing to achieve. Since BSSO has been introduced, the stability of BSSO has been analyzed in many studies [2, 3].

Osteotomies in the vertical ramus have been the preferred technique for correcting developmental deformities of the mandible. This preference has increased with closer cooperation between orthodontists and surgeons in treating dentofacial deformities. Operations in the vertical ramus, therefore, have become almost automatically considered when the dental arch as a unit has to be moved [4].

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The relapse of mandibular surgery has been analyzed mainly by horizontal measurements. However, relapse needs to be classified into horizontal and vertical types to evaluate its patterns and causes [5].

Postoperative change in skeletal and dental position following the use of IVRO in the treatment of mandibular horizontal excess has received much attention. Goldstein was the first to use serial cephalograms to evaluate the postoperative change of the mandible after surgical correction of the mandibular prognathism [6].

The aim of the present prospective study aimed to measure and compare the postoperative horizontal and vertical changes (relapse) that occur at B point and pogonion after intraoral vertical ramus osteotomy (IVRO) without fixation and bilateral sagittal split osteotomy (BSSO) with semi rigid internal fixation in bimax surgery.

Materials and Methods

Eleven patients with skeletal class III malocclusion, mandibular prognathism and maxillary hypoplasia were chosen. The patients have attended the service of maxillofacial surgery in the General Assembly of Damascus Hospital. The equipment, instruments and material used include all the basic and special surgical instruments used in orthognathic surgery.

Eleven patients were included in this study based on the following criteria:

1. Mandibular prognathism of < 7 mm without chin deviation
2. Mandibular setback through a BSSO, VO without genioplasty and with Lef I osteotomy.
3. Postoperative radiographs with a follow-up of 12 months or longer.
4. No history of associated trauma or craniofacial anomaly. Patients who complained preoperatively of symptoms in the TMJ such as pain, crepitus, clicking, popping and closed lock were excluded from the study.
5. All patients have malocclusion.
6. Facial appearance was often the patient's main concern.

In this prospective study, the subjects were randomized to undergo either BSSO ($n = 6$) or IVRO ($n = 5$) according to an adaptive random assignment procedure that balanced treatment groups on the basis of degree of over jet and over bite. The research protocol was approved by the Ethical Committee of the Hospital. All patients gave written consent for the study.

The study consisted of six males (54.5 %) and five females (45.4 %). Their mean age at the time of surgery was 23 years with a range of 19–27 years. All the cases underwent mandibular setback as follows:

Six cases underwent BSSO; Five IVRO. All operations were performed by the same teams

The mean of over bite and over jet for all patients are shown in Tables 1 and 2.

All the basic dental model analysis with presurgical orthodontic and post surgical orthodontic treatment was offered for the patients treated by the same orthodontist (the mean of presurgical orthodontic treatment was 17.29 months and the mean of post surgical orthodontic treatments was 6.27 months.

The radiographic and imaging analysis included full-mouth periapical radiograph, panoramic radiograph, computed tomography and 3-D computed tomography for evaluation of amount of ramus thickness.

Surgical Treatment

In BSSO, soft tissue dissection was performed in the standard fashion (DalPont) and semi rigid fixation (2.0 mm *manipulating* mini-plating system) was accomplished with a titanium manipulate miniplate at the anterior mandibular ramus. IVRO was performed without using any fixation systems. A horizontal osteotomy for the Le Fort I was accomplished and stabilized in its desired position using titanium manipulates miniplates and screws in the perform piriform aperture and maxillary buttress region bilaterally. Maxillo-mandibular fixation (MMF) was released at 6–8 weeks after surgery in both the IVRO and BSSO groups to bring the teeth in their normal occlusion state. Elastic tractions were used until at least 3 months after surgery to functionally control the postsurgical mandibular positions. Patients were followed-up and recalled every day during the first week.

All the cases underwent horizontal setback and vertical downward movement at B-point and pogonion according to pre orthodontics preparation and the opinion of orthodontist in order to restore the maximum oral and maxillofacial function and aesthetics using the lateral cephalometric study in addition to the some intraoperative changes during the surgery. The final amount of total movement immediately after surgery according to the cephalometric studies is shown in Table 3.

The radiographs were taken with the same equipment and analyzed by one investigator.

Table 1 Degree of over bite (mm)

Operation	N	OB	±SD	SE	CV %	Min.	Max.
IVRO	5	1.2	0.72	0.32	0.6	0.5	2.0
BSSO	6	1.33	0.75	0.30	0.5	0.5	2.5

N number, *OB* over bite, *SD* standard deviation, *SE* standard error, *CV* Coefficient of variance, *min* minimum value, *max* maximum value

Table 2 Degree of over jet (mm)

Operation	N	OJ (mm)	±SD	SE	CV %	Min.	Max.
IVRO	5	−3.3	1.44	0.64	0.4	2.5	5.0
BSSO	6	−4.5	1.83	0.75	0.4	1.5	6.5

N number, *OJ* over jet, *SD* standard deviation, *SE* standard error, *CV* Coefficient of variance, *min* minimum value, *max* maximum value

Table 3 Degrees of surgical movement

Operation	HB-Point	H pogonion	VB-Point	V pogonion
IVRO	5.04 ± 1.10	5.66 ± 1.2	1.4 ± 0.41	1.06 ± 0.29
BSSO	5.33 ± 1.24	5.88 ± 1.19	1.25 ± 0.41	0.95 ± 0.33

H horizontal, *V* vertical

Subject Assessments

Cephalograms were taken at T0 and T1, with MMF and occlusal splints in place. At T2, cephalograms were taken in centric occlusion with elastics released and without the occlusal splints.

Cephalometric Measurements

The linear measures on lateral cephalograms used in this study are illustrated in Fig. 1.

X and Y coordinate measurements were obtained by using: A line parallel to the Frankfort horizontal plane at the nasion for the x coordinate and a perpendicular line drawn intersecting the first line at the nasion.

These x and y coordinated axes were transcribed onto each successive radiograph by superimposition on the best fit of cranial base landmarks. Changes in the positions of the B-point and the pogonion were measured. The relevant points were indicated on the x- and y-axes. Movements of these points were represented as linear measurements in millimeters on both the axes. On the x-axis, anterior movement was indicated as a positive value and posterior movement as a negative value. On the y-axis, superior movement was indicated as a positive value and inferior movement as a negative value.

Four measures of movement of distal segments were used,

1. Horizontal change of the B point.
2. Vertical change of the B point.
3. Horizontal change of the pogonion.
4. Vertical change of the pogonion.

Measurements Errors and Statistical Analysis

The changes during the surgery were measured by cephalometric indices and all the measurements were performed

Fig. 1 Method of analyzing lateral cephalograms

twice and on two consecutive days. The errors of the two sets of tracings and measurements were estimated by paired sample t test and the Dahlberg formula, although the magnitude of measurement error was below 1 mm for all the horizontal and vertical measurements. These small differences were not significant.

Statistical Analysis

The result of study was analyzed by the following statistical methods:

1. Descriptive statistics included: Mean, standard deviation (SD), standard error (SE), coefficient of variance (C %), two extreme values (maximum and minimum).
2. To evaluate surgical relapse, horizontal and vertical, measurements of T0, T1 and T2 were compared.

Results

Postoperative changes (relapse) of B point (x,y)

Postoperative changes (relapse) of B point from 1 week post operatively (T0) to 1 year post operatively (T2) were

assessed. The mean of movement at 1 month post operatively (T1) to 1 year post operatively (T2) is shown in the Table 4.

Postoperative changes (relapse) of Pogonion (x,y)

Postoperative changes (relapse) of pogonion from 1 week post operatively (T0) to 1 year post operatively (T2) were assessed. The mean of movement at 1 month post operatively (T1) to 1 year post operatively (T2) is shown in the Table 5.

Postoperative changes (relapse) at 1 year postoperatively (T2)

Postoperative changes (relapse) of B-point and pogonion at 1 year post operatively (T2) were assessed and compared with the amount of setback and the percentage of relapse of each point and each axis. The CV, SE and the percentage of relapse are shown in the Table 6.

In all the cases, the maxilla was displaced upward at surgery both posteriorly at posterior nasal spine and anteriorly with no significant relapse observed during follow-up.

The movement of the IVRO group was as follows:

1. The mean horizontal surgical setback at B point was 5.04 ± 1.10 mm with an average horizontal displacement of 1.4 ± 0.41 mm (or 27.77 %).
2. The mean horizontal surgical setback at pogonion was 5.66 ± 1.2 mm with an average horizontal displacement of 2.3 ± 0.57 mm (or 40.63 %).
3. The mean downward surgical movement at B point was 1.4 ± 0.41 mm with an average vertical displacement of 0.8 ± 0.29 mm (or 57.14 %).
4. The mean downward surgical movement at pogonion was 1.06 ± 0.29 mm with an average vertical displacement of 0.72 ± 0.22 mm (or 67.92 %).

The movement of the BSSO group was as follows:

1. The mean horizontal surgical setback at B point was 5.33 ± 1.24 mm with an average horizontal displacement of 1.5 ± 0.44 mm (or 28.14 %).

2. The mean horizontal surgical setback at pogonion was 5.88 ± 1.19 mm with an average horizontal displacement of 2.41 ± 0.57 mm (or 40.98 %).
3. The mean downward surgical movement at B point was 1.25 m with an average vertical displacement of 0.88 ± 0.41 mm (or 70.40 %).
4. The mean downward surgical movement at pogonion was 0.95 ± 0.33 mm with an average vertical displacement of 0.60 ± 0.23 mm (or 63.15 %).

Discussion

Mandibular setback osteotomy is commonly used in the Asian patient having a skeletal Class III malocclusion with a relatively flat midface [5]. Relapse after surgery occurred with decrease of vertical height and with few horizontal changes although other studies reported that the horizontal and vertical relapse for mandibular setback had broad variance [7–9].

In the literature, some authors report (50 %) of skeletal relapse [10, 11]. However other articles reported only about (30 %) or less [12–14].

The incidence of horizontal relapse in another study was (75 %) [15]. In the literature, skeletal relapse has been reported during IMF [5, 15, 16]. However, in our study, we ensured the correct position of the mandibular condyle in glenoid fossae during IMF period. In addition, panoramic radiographs were taken in the immediate postoperative period to check the correct position of the condyle. We could see that the skeletal relapse was evident immediately after removal of IMF and not during the IMF period. Mandibular prognathic patients often have an anterior open bite.

Therefore, it may partly explain the greater vertical relapse than horizontal relapse shown in this study which agrees with Kim et al. [17] who said that surgery may involve changes to close the anterior bite and open the posterior bite and this may cause an increase of posterior vertical height and induce muscle lengthening in the vertical direction. But this explanation cannot be applied to our study because no patients with open bite were included in the present study.

Table 4 The mean of movement at B point (x,y)

Operation	N	Axis	Setback Mean	T0–T1 (mm)	SD $\pm$	T0–T2 (mm)	SD $\pm$
IVRO	5	x	−5.04	−0.8	0.25	−1.4	0.41
IVRO		y	−1.4	−0.56	0.08	−0.8	0.29
BSSO	6	x	−5.33	+0.83	0.24	+1.5	0.44
BSSO		y	−1.25	+0.60	0.29	+0.88	0.32

N number, SD standard deviation

Table 5 The mean of movement at pogonion (x,y)

Operation	N	Axis	Setback Mean	T0–T1 (mm)	SD $\pm$	T0–T2 (mm)	SD $\pm$
IVRO	5	x	–5.66	–1.2	0.44	–2.3	0.57
IVRO		y	–1.06	–0.42	0.12	–0.72	0.22
BSSO	6	x	–5.88	+1.33	0.5	+2.41	0.57
BSSO		y	–0.95	+0.35	0.11	+0.60	0.23

N number, SD standard deviation

Table 6 Postoperative changes (relapse) at 1 year postoperatively

Operation	N	Point	Axis	Mov. Mean (mm)	SD $\pm$	Relap. Mean (mm)	SD $\pm$	SE	CV %	Percentage of Relapse
IVRO	5	B.	x	–5.04	1.10	–1.4	0.41	0.18	0.2	27.7
IVRO		B.	y	–1.4	0.41	–0.8	0.29	0.13	0.3	57.1
IVRO		Pog.	x	–5.66	1.2	–2.3	0.57	0.25	0.2	40.6
IVRO		Pog.	y	–1.06	0.29	–0.72	0.22	0.09	0.3	67.9
BSSO	6	B.	x	–5.33	1.24	+1.5	0.44	0.18	0.2	28.1
BSSO		B.	y	–1.25	0.41	+0.88	0.32	0.13	0.3	70.4
BSSO		Pog.	x	–5.88	1.19	+2.41	0.57	0.23	0.2	40.9
BSSO		Pog.	y	–0.95	0.33	+0.60	0.23	0.09	0.3	63.1

N number, Mov movement, SD standard deviation, SE standard error, Relap relapse, CV Coefficient of variance, Pog pogonion

The IVRO group

Recently, IVRO has been used widely in patients undergoing orthognathic surgery of jaw. This procedure is relatively easy and only a few cases have shown sensory disturbances in the mental region due to surgical damage of the inferior alveolar nerve [18]. The incidence of inferior alveolar nerve injury associated with VRO is <1 % [19].

Conversely, neurologic deficit associated with BSSO has been reported to be as high as (85 %) [20, 21] and complete transaction of nerve has a reported incidence of (2–3.5 %). [22, 23]. Another benefit of IVRO is the ability to reposition the condyle [18].

Postoperative change in skeletal and dental position following the use of an IVRO in the treatment of mandibular horizontal excess has received much attention. Although the incidence of temporomandibular joint internal derangement is low after BSSO; it is even lower after IVRO. The stability of any mandibular ramus osteotomy is affected by the amount of retrusion, the method of fixation, and growth [24, 25]. This amount of average relapse has surprisingly remained fairly consistent throughout the history of this technique, even though technical changes in procedures have been made [26, 27]. Kim and colleagues noted that the variation in the amount of relapse in mandibular setbacks was large and attempts at identifying controllable variables should be made [28]. The finding that the pogonion tends to move

posteroinferiorly during intermaxillary fixation has been well documented [29].

It will be noted among the subjects of this study that the horizontal relapse for IVRO with more than 5 mm horizontal surgical setback is (27.7 %) at B point and a greater number i.e., 40.63 %, at pogonion. However, the results of the present study clearly show that there are no significant differences in relapse in horizontal direction at B point and pogonion point after IVRO as compared with the BSSO group, and are in agreement with other studies [30–32].

Kwon et al. [30] observed that the BSSO with wire osteosynthesis showed significantly greater relapse in SNB angle and more anterior movement of the B-point, menton, and pogonion than the IVRO group.

The BSSO group

Bilateral sagittal split osteotomy is the most widely used surgical procedure for the management of mandibular prognathism [33]. Surgeons [34–36] have used rigid skeletal fixation with bicortical screws, which allows for early postoperative mobilization after BSSO. However, relatively few studies have addressed the stability of sagittal split setback osteotomies rigidly fixated with bicortical screws without postoperative IMF [33, 35, 36]. Martis stated that relapse rates have been reported to range from 6 % to 80 % after BSSO in which wire osteosynthesis was used to stabilize the fragments [37].

In fact the reported horizontal relapse rates for isolated mandibular setback in both rigid fixation and non rigid fixation techniques show a great variation from 0.2 to 4.2 mm (2.3–91.3 %) [7, 9, 12, 15, 34, 38–44]. However, with regard to the vertical relapse most authors uniformly reported minimal values [5]. In the 1980s, rigid fixation techniques, using miniplates, screws, or both, were introduced to reduce the rate of postsurgical relapse. In comparison, negligible relapse was reported when more rigid fixation was used [45, 46]. It will be noted among the subjects of this study that the horizontal relapse for BSSO with more than 5 mm horizontal surgical setback is (28.1 %) having B point and a greater number i.e., (40.9 %) at pogonion.

Conclusion

The percentage of horizontal relapse after IVRO without fixation is equal to that after BSSO with semirigid internal fixation.

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