

Changes of Transverse Mandibular Width in Set-Back Mandibular Surgery: Sagittal Split versus Intraoral Verticosagittal Osteotomy

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Abstract

Aim: This study was performed to evaluate the movement of the proximal segment following different methods of ramus osteotomy that is one of the side effects of orthognathic surgery. Theoretically, with intraoral verticosagittal ramus osteotomy, it can minimize the movement of the proximal segment. The changes in the intergonial distance of mandible and the angle of the ramus flaring in two methods of osteotomy have been compared in this study. **Materials and Methods:** In this randomized clinical trial, included 60 patients (32 males) with mandibular prognathism and without any asymmetry were selected and divided into two groups (n = 30). One group underwent bilateral sagittal split ramus osteotomy technique to achieve mandibular setback and the other by the intraoral verticosagittal ramus osteotomy technique. Intergonial width and inner-ramal angle in the transverse plane were measured on radiographs preoperatively and 1 and 12 weeks postoperatively. Data were analyzed using covariance test with the significance level set at $P < 0.05$. **Results:** Changes of intergonial width and inter-ramal angle was significant in both the 1 and 12-week radiographies taken post-operative in both groups. But no statistically significant difference was observed in the intergonial width and ramus flaring at the mentioned time points between the two groups ($P > 0.1$). **Conclusion:** Considering our findings, there was no significant difference between two ramus osteotomy techniques regarding changes in mandibular width and inter-ramal flaring angle.

Keywords

Bilateral Sagittal Split Ramus Osteotomy (BSSRO), Intraoral Verticosagittal

Ramus Osteotomy (IVSRO), Intergonial Width, Mandibular Prognathism, Inter Ramal Angle

1. Introduction

Osteotomy of the mandibular ramus by Bilateral Sagittal Split Ramus Osteotomy (BSSRO), which was first introduced by Trauner and Obwegeser in 1957, is widely used to correct mandibular prognathism and retrognathism [1].

Due to the desired bone contact resulting from this technique between the two segments and the possibility of full fixation of these segments, besides the support of the vast research conducted in this respect, BSSRO is considered as the conventional method in mandibular osteotomy [2].

By this type of osteotomy and in order to set-back the mandible, the lateral cortex of the ramus is split and following the set back of the distal segment due to the bone contact between the sponge bones in the lateral aspect of the distal segment and the medial aspect of the proximal segment, the proximal segment is slightly drawn to the lateral side leaving triangular spaces in the anterior and posterior aspect of the bones' contact sites. The application of rigid fixation by two positional screws can minimize lateral movements as well as shrinking the size of such spaces. In this way, the bone is better healed and the increase in the intergonial width is minimized [3].

The prevalence of hypoesthesia from inferior alveolar nerve injury ranges from 0% - 20% and has been found to be greater when performed concurrently with inferior border osteotomy [4] [5]. Most of such injuries are caused during dissection and osteotomy of the medial aspect of the ramus or the buccal aspect or when using the osteotome [6]. In 1992, Choung *et al.* conducted research on the ramus diameter with the help of CT scan; accordingly they introduced a new technique named "Intraoral Vesico-Sagittal Ramus Osteotomy" (IVSRO) [7].

In this technique with the use of sufficient thickness of the cortex and sponge bone, bone split is performed in the posterior wall of the mandibular fossa up to the posterior border on a plane which is as parallel as possible to the sagittal body plane.

Nevertheless, by setting back the distal segment, premature bone contacts in the posterior regions of the ramus are minimized and fewer vacant spaces are formed. Therefore, the increase in the intergonial width is theoretically minimized [8].

Clinical experiences regarding the use of Choung's method have shown its success in reducing neurological complications besides its technical simplicity [9]. It seems that due to the localization of the osteotomy site in the posterior wall of the mandibular fossa and lateral access, the rate of neurological injury and the surgical time is reduced. Given that an increase in the intergonial width following mandibular osteotomy is one of the undesirable surgical outcomes, the

capability of a surgical technique to reduce this complication is regarded as a major advantage [10].

In the present study, following BSSRO and IVSRO, cephalometric evaluation of bone changes in the proximal segment of the mandible was done. Moreover, changes in the intergonial width and the inter-ramal angle in the horizontal plane were compared between the two techniques.

2. Materials and Methods

This randomized clinical trial was conducted from 2013 to 2016 on 60 patients with mandibular prognathism without any asymmetry who were referred to the Oral and Maxillofacial Surgery clinic of Shariati Hospital, Tehran, Iran and a private office.

The study protocol was approved by the local Ethics Committee and a written informed consent was obtained from each participant prior to study entrance.

Clinical examination, radiographic evaluation, dental casts, routine face and cephalometric analyses were performed for all patients at the beginning of the study.

They all had skeletodontal deformities of the mandibular prognathism type with or without maxillary deformity. None of the patients had asymmetry or occlusal cant. All cases with metabolic bone disease or other underlying diseases affecting bone metabolism such as long-term corticosteroid usage, anemia, thalassemia, hemophilia and fibrodysplasia were excluded from the study. Routine lab tests were performed before surgery for each subject.

For pre-operative evaluation, radiographic imaging including panoramic and posterior-anterior (PA) cephalometry, lateral cephalometry and submentovertex x-ray were requested. They were also repeated one and 12 weeks after the operation. These radiographs were performed in the Natural Head Position (NHP) by a single technician and apparatus in the same medical center. In order to measure the intergonial distance, the lowest and most infero-lateral visible part of the ramal outline at the mandibular angle was marked on the PA cephalometry and their distance was measured and recorded by a caliper.

The extension of the proximal segment of the ramus bone was marked in the submentovertex radiography and the inter-ramal angle was measured by a protractor.

The studied cases were randomly assigned into two groups by using the table of random numbers. Patients in the first group underwent bilateral sagittal split ramus osteotomy with Obwegeser-Dal Pont's modification. For patients in the second group, the intraoral sagittal ramus osteotomy technique with Straight or Choung II modification was performed. In both groups the rigid method was applied for bone segments fixation using two bicortical or positional screws in each side. All surgeries were performed by the same surgeon. The collected data were analyzed by SPSS ver.16 and a $P < 0.05$ was considered as statistically significant.

3. Results

In total 60 cases, 32 males and 28 females with the mean age of 26.2 yrs were studied. The mean mandibular set back in the BSSRO group was 4.9 mm which was 4.5 mm in the IVSRO group (**Table 1**).

The mean intergonial distance was 98.7 ± 3.2 mm in the BSSRO group before surgery. It increased to 102.6 ± 2.5 mm and 102.4 ± 2.2 mm one and 12 weeks following surgery, respectively, and in the IVSRO group was 98.1 ± 3.2 mm before surgery which increased to 101.7 ± 3.6 mm and 102.3 ± 3.2 mm one and 12 weeks after surgery, respectively (**Table 2**).

The mean intergonial width changes in the IVSRO group were 3.9 mm one week and 3.7 mm 12 weeks after the operation. The same figures were 3.7 mm and 4.2 mm in the BSSRO group, respectively. The difference between the two osteotomy techniques was not statistically significant in this respect after one and 12 weeks ($P = 0.557$, $P = 0.491$). The mean angle between the left and right ramus in the submentovertex radiography was 31.6 ± 1.6 degree in the BSSRO group; it increased to 32.1 ± 1.0 and 32.4 ± 1.2 degree one and 12 weeks following surgery, respectively. The same variable was 30.5 ± 1.4 degree in the IVSRO group and increased to 30.5 ± 1.4 and 31.4 ± 1.3 degree at the aforementioned time points (**Table 3**).

Comparison of the changes related to ramus flaring in the two studied osteotomy types are presented in **Table 4**. The increase in inter-ramal angle based on analyses of covariance showed no significant difference between the two groups after one week ($P = 0.885$); a similar result was obtained after 12 weeks ($P = 0.276$).

Table 1. Correlation of the mean mandibular setback and increase of inter-agonal width between the two osteotomy techniques before and after surgery.

	Mean set. back Mandible	mean increase of width after1 week	mean increase of width after12 week
IVRO* n = 30	4.5	3.9	3.7
BSSRO** n = 30	4.9	3.7	4.2

*Intraoral verticosagittal ramus osteotomy; **Bilateral sagittal split ramus osteotomy.

Table 2. Comparison of inter-agonal distance between the two osteotomy techniques before and after surgery.

	Measurement Time	mean	Standard Deviation
IVRO* n = 30	Before Surgery	98.7	3.2
	1 week after surgery	102.6	2.5
	12 week after surgery	102.4	2.2
BSSRO** n = 30	Before Surgery	98.1	3.2
	1 week after surgery	101.17	3.6
	12 week after surgery	102.3	3.2

*Intraoral verticosagittal ramus osteotomy; **Bilateral sagittal split ramus osteotomy.

Table 3. Comparison of the inter-ramal angle between the two osteotomy techniques before and after surgery.

	Measurement time	Minimum	Maximum	Mean	Standard deviation
IVSRO* (n = 30)	Before surgery	28	32	30.5	1.4
	1 week after surgery	30	34	31.4	1.3
	12 weeks after surgery	30	33	31.4	1
BSSRO** (n = 30)	Before surgery	29	34	31.6	1.6
	1 week after surgery	31	34	32.1	1
	12 weeks after surgery	30	34	32.4	1.2

*Intraoral verticosagittal ramus osteotomy; **Bilateral sagittal split ramus osteotomy.

Table 4. Comparison of the inter-ramal angle changes between the two osteotomy techniques.

Osteotomy	Measurement time	Minimum	Maximum	Mean	Standard deviation
IVSRO* (n = 30)	At 1 week	0	2	0.9	0.7
	At 12 weeks	0	2	0.9	0.9
BSSRO** (n = 30)	At 1 week	-1	2	0.5	0.8
	At 12 weeks	-1	2	0.8	1.0

*Intraoral verticosagittal ramus osteotomy; **Bilateral sagittal split ramus osteotomy.

4. Discussion

This study compared the effect of two osteotomy techniques of the mandibular ramus on the increase in intergonial width and ramus flaring as indicators of the proximal segment movement. An increase in the mandibular width and ramus flaring in addition to affecting the width of the lower one third of the face can cause condylar rotation and changes in the temporomandibular joint. Studies performed on condylar movement following orthognathic surgery show that ramus osteotomy can result in the proximal segment dropping and displacement of the condylar head from the joint cavity in the antero-inferior direction. The severity of this phenomenon is greater in subcondylar vertical osteotomies in comparison to sagittal split osteotomies [11].

To date, several studies have investigated the effect of different osteotomy techniques on the rotation of the proximal segment and the mandibular width. Watzke *et al.* reported increased intergonial distance when studying sagittal split osteotomies with advancement [12]. The same result was reported by Choi *et al.* in sagittal split osteotomy with mandibular set-back [13].

Ueki *et al.* also compared intraoral vertical and sagittal osteotomies and stated that mandibular set-back with the sagittal split technique causes the inward rotation of the mediolateral axis of the condylar head; whereas IVRO results in the outward rotation of the condylar head [14]. Some researchers studying the causes and factors affecting such rotations believe that if the ramus osteotomy plane is precisely parallel to the sagittal plane, when setting back the distal segment,

the proximal segment will experience the least amount of change [12]. The Choung osteotomy technique was also designed with the aim of parallelism of the osteotomy plane with the sagittal body plane. Yet, no study has been performed investigating the ability of this technique in reducing undesired movements in comparison to other widely-used techniques.

Yazdi *et al.* studied intraoral vertical and sagittal osteotomies by the Obwegeser technique and concluded that in mandibular set-back the intergonial angle reduces in all subjects; this reduction is greater in the IVSRO technique [15]. Ju-hung Pan *et al.* studied the sagittal and transverse angles of the proximal segment following sagittal and vertical ramus osteotomies along with their effect on the distal segment stability. They reported that these angles increase significantly after vertical osteotomy and then relapse. This increase is milder in the sagittal technique and remains stable. The significant increase in the transverse angle is related to the rotation in the distal segment during the remodeling of both surgeries. However, increase in the inclination angle of the ramus is associated with the anterior movement of the distal segment which only occurs in sagittal surgeries [16].

Choi *et al.* studied the long-term changes in face and mandibular width following IVSRO with mandibular set-back. They concluded that the mandibular width increases after this type of surgery but returns to normal after around 3 years. Asskeletal changes in the facial inferior width are not affected, therefore, long-term transverse changes are not significant in this osteotomy technique [17].

Yoo *et al.* also evaluated the correlation between the transverse displacement of the proximal segment after bilateral sagittal split ramus osteotomy for mandibular set back surgery; they concluded that both the inter-gonial width and the inter-ramal width increase immediately after surgery [18].

In the present study the changes resulting from the two osteotomy techniques in mandibular set-back were evaluated and compared. An increase in the mandibular width was observed in all patients. However, regarding the movements of the proximal segment, no significant difference was achieved between the two techniques.

5. Conclusions

Nevertheless, due to our small study population and restricted equipments, more extensive studies are recommended to be performed in this scientific field. Moreover, as reduced neurological deficit and simplicity of performance are the main advantages of this technique, further studies are recommended to focus on the stability of osteotomy outcomes, the effect of osteotomy on TMJ symptoms and the prevalence of inferior alveolar nerve injuries in this technique.

Ethics in Publishing

The study protocol was approved by the local Ethics Committee of Tehran Uni-

versity of Medical Sciences and a written informed consent was obtained from each participant prior to study entrance.

Conflict of Interest

None.

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