Skeletal Relapse Following Sagittal Split Ramus Osteotomy Advancement

Nanda Kishore Sahoo · Balakrishnan Jayan ·
Ankur Thakral · Vishvaroop Nagpal

Received: 24 January 2014 / Accepted: 14 June 2014 / Published online: 13 September 2014
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Abstract

Background Sagittal split ramus osteotomy (SSRO) is an accepted and standard procedure to address mandibular corpus deficiency. The relapse following the mandibular advancement has a negative impact both on clinician and patient.

Purpose To analyse the hard tissue changes and to investigate relapse following SSRO advancement procedure.

Materials and Methods A retrospective review of 21 patients treated by bilateral SSRO advancement at our institute was conducted. Lateral cephalograms obtained at pre-treatment (T1), pre-surgery (T2), 2 months (T3) and 2 years post-surgery (T4) were evaluated by an independent investigator. The data T2–T3 revealed immediate postoperative changes, and T3–T4 revealed skeletal relapse following surgery after 2 years.

Results Twelve females and nine males with age ranging from 16 to 24 years underwent mandibular advancement. The mean follow-up period was 2 years 7 months $\pm$ 4 months. The mean mandibular advancement at pogonion was 5.1 ± 1.25 mm with significant improvement in SNB, ANB, CoGn, maxillo-mandibular differential and SN:GoPg ratio following surgery. Comparison of the outcomes following surgery revealed that the mean relapse at pogonion was 0.2 ± 0.44 mm. B point, mandibular corpus length, anterior and posterior facial height remained

stable with no significant relapse following mandibular advancement.

Conclusion Sagittal split ramus osteotomy within the range of mandibular advancement is a stable procedure.

Keywords Sagittal split ramus osteotomy · Mandibular advancement · Relapse

Introduction

Skeletal class II malocclusions resulting from mandibular retrognathism often require a combined orthodontic and surgical approach for correction of the deformity. Orthognathic surgery makes it possible to treat skeletal and dental deformities that are beyond the reach of orthodontic therapy alone. Sagittal split ramus osteotomy (SSRO) is the most favoured surgical technique for mandibular advancement [1]. The goal is to achieve optimal functional outcomes, good aesthetic results and satisfaction of patients' concerns. However, one factor that still remains a major concern in the surgical correction of mandibular retrognathism is its potential for relapse. Relapse is a distressing complication not only to the treating orthodontist and maxillofacial surgeon, but even more to the patient.

Stability following mandibular advancement procedures has been divided into short-term and long-term relapse. When it occurs within 6–8 weeks of surgery, it is known as early relapse and is usually due to movement at the osteotomy site [2]. Insufficient intraoperative positioning of the condyle, resulting in subsequent condylar displacement and osteotomy slippage, are thought to contribute to early skeletal relapse [3, 4]. On the other hand, late skeletal relapse is thought to be caused by progressive condylar resorption [5].

N. K. Sahoo (✉) · B. Jayan · V. Nagpal
Department of Dental Surgery, Armed Forces Medical College,
Pune 411040, Maharashtra, India
e-mail: colnksahoo@gmail.com

A. Thakral
15 Corps Dental Unit, C/O 56 APO, Pune 903515, India

Some of the factors contributing to relapse include magnitude of distal segment advancement, condylar malposition in the glenoid fossa, posterior migration in response to soft tissue and muscle pull, lack of control of the proximal segment during surgery and inadequate fixation periods or method of fixation. As the magnitude of advancement increases, so does the net amount of relapse because of increased stretch and tension in the soft tissue envelope and smaller cross-sectional area of bone contact [6].

Skeletal changes were seen at the condyle of the temporomandibular joint (TMJ) and along the mandibular corpus and the ramus following mandibular advancement by bilateral SSRO. The purpose of this retrospective study was to analyse the hard tissue changes and to investigate relapse following mandibular advancement with SSRO procedure.

Material and Methodology

This retrospective study was carried out in the Department of Dental Surgery, Armed Forces Medical College, Pune from Jan 2008 to Dec 2010. A total of 39 cases were operated for bilateral sagittal split ramus osteotomy, out of which 21 cases were included in the study. The cases treated only for mandibular advancement, having all relevant pre and postoperative photographs, radiographs and models and those who have completed minimum of 2 years post-surgical follow up were included in the study. Patients with pre-existing TMJ disorders, syndromic and medically compromised cases and who underwent combination orthognathic procedures were excluded from the study. The study did not require any investigations or interventions to be conducted in patients and therefore approval from the Ethics Committee was not required.

Surgical Procedure

Occlusal splint was fabricated pre-surgically as per the standard institutional protocol following face bow transfer. All operations were performed by single experienced oral and maxillofacial surgeon. Bilateral SSRO as described by Hunsuck [7] was carried out in all cases. The distal segment was advanced and placed in occlusion as guided by the surgical splint and inter maxillary fixation was done. The condyles were seated in the glenoid fossa by manual repositioning. The gap between the proximal and distal segment was confirmed as per the plan. The segments were then stabilized by mini bone plate and 7 mm monocortical screws with at least two screws in each segment. Standard post-operative protocol was followed. The splint was cemented to upper arch on second post-operative day and

maintained for 2 weeks to guide the mandible to new occlusion. All cases continued with post-surgical orthodontic treatment.

Data Evaluation

The lateral cephalograms with the Frankfort horizontal plane parallel to the floor were taken at pre-treatment (T1), pre-surgery (T2), 2 months (T3) and 2 years post-surgery (T4). An independent investigator traced the radiographs on acetate paper and the landmarks were verified by two other investigators not associated with the study. Suspicious structures and landmarks were retraced to the mutual satisfaction of the investigators. A single average tracing was made in instances of bilateral structures. Twelve hard tissue parameters were utilised for cephalometric analysis and all measurements were obtained twice following a period of 1 month by the same investigator.

Statistical Analysis

All data were analysed by statistical analysis package SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). Data were analysed for intra-observer correlation using the Mann–Whitney U test. Mean and standard deviation values were calculated for the evaluation parameters at T1, T2, T3, and T4 time intervals. The data T1–T2 revealed changes following pre-surgical orthodontic treatment, T2–T3 revealed immediate postoperative changes, and T3–T4 revealed skeletal relapse following SSRO procedure after 2 years. A one-factor repeated-measures ANOVA with post hoc Bonferroni test was used for multiple comparisons at various time intervals and *p* value <.05 was considered to be statistically significant.

Results

Thirty nine patients, from Jan 2008 to Dec 2010, underwent SSRO for mandibular advancement at our institute. Out of them, 21 patients (12 females and nine males) who fulfilled the inclusion criteria were included in this study. The age of these patients ranged from 16 to 24 years with the average age being 19.5 ± 2.32 years. The follow-up period ranged from 2 years 1 month to 3 years 2 months with a mean of 2 years 7 months ± 4 months.

The mean and standard deviation values of all parameters at various time intervals are presented in Table 1. All measurements showed a highly significant intra-observer correlation ($r = .9918$, $p < .01$). The mean pre-treatment SNA, SNB, ANB and Pog-Na values indicated skeletal class II malocclusion secondary to mandibular deficiency.

Table 1 Mean and standard deviations of various parameters measured on lateral cephalogram at various time intervals

Measurements	T1 (pre-treatment)		T2 (pre-surgical)		T3 (2 months after surgery)		T4 (≥ 2 years after surgery)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
SNA	79.70	4.423	80.20	4.849	79.75	4.380	79.30	4.111
SNB	74.25	3.646	74.50	4.116	76.90	3.604	76.70	3.057
ANB	5.45	1.423	5.70	1.337	2.85	1.700	2.60	1.897
Pog-Na	−12.70	6.567	−14.10	6.806	−9.00	5.869	−9.20	5.266
CoA	87.40	5.232	87.65	3.367	88.10	3.348	87.10	4.701
CoGn	106.80	6.268	107.30	5.832	112.20	6.088	111.20	7.997
Max-Mand	19.40	4.575	19.60	4.624	24.10	5.087	24.10	4.977
LAFH	61.80	8.121	62.90	8.875	67.70	9.429	65.40	10.362
FMA	17.80	8.664	18.50	8.489	22.25	7.743	22.20	7.330
GoGn-SN	25.40	9.180	26.00	8.327	30.60	8.488	30.60	8.501
Jaraback	70.58	7.037	71.04	6.672	65.41	5.861	65.45	5.665
SN:GoPg	1.037	.0910	1.040	.0794	1.088	.0725	1.085	.0726

Table 2 Statistical analysis of various parameters before and after pre-surgical orthodontic treatment (T1–T2)

Measurements	Mean difference	SE	<i>p</i> value	Significance
SNA	−.500	.637	1.000	NS
SNB	−.250	.574	1.000	NS
ANB	−.250	.375	1.000	NS
Pog-Na	1.400	.600	.267	NS
CoA	−.250	.958	1.000	NS
CoGn	−.500	1.213	1.000	NS
Max-Mand	−.200	.727	1.000	NS
FMA	−.700	.539	1.000	NS
LAFH	−1.100	.482	.290	NS
GoGn-SN	−.600	.833	1.000	NS
Jaraback	−.456	.782	1.000	NS
SN:GoPg	−.003	.008	1.000	NS

Table 3 Statistical analysis of various parameters before and 2 months after surgery (T2–T3)

Measurements	Mean difference	SE	<i>p</i> value	Significance
SNA	.450	.353	1.000	NS
SNB	−2.400	.427	.002	Sig
ANB	2.850	.472	.001	HS
Pog-Na	−5.100	1.251	.017	Sig
CoA	−.450	.950	1.000	NS
CoGn	−4.900	1.100	.010	Sig
Max-Mand	−4.500	.582	.000	HS
LAFH	−4.800	1.114	.012	Sig
FMA	−3.750	.847	.010	Sig
GoGn-SN	−4.600	.921	.004	Sig
Jaraback	5.631	.593	.000	HS
SN:GoPg	−.048	.007	.000	HS

CoA, Co-Gn, maxillo-mandibular differential and lower anterior facial height values revealed anteroposterior deficiency of mandible with normal lower anterior facial height. The mandibular plane angle with Frankfort horizontal and anterior cranial base suggested a low mandibular plane. There is a minor change in the cephalometric parameters at pre-treatment (T1) and pre-surgical (T2) stage which is statistically not significant (Table 2).

The mean mandibular advancement by SSRO procedure at pogonion was 5.1 ± 1.25 mm. The mandibular parameters reflected improvement in the mean SNB, ANB, Co-Gn, maxillo-mandibular differential and SN:GoPg ratio. The mean lower anterior facial height increased and the mean Jaraback ratio decreased. The mean mandibular plane angle with Frankfort horizontal and anterior cranial base approached towards normal values. Comparison of the treatment outcomes following mandibular advancement

Table 4 Statistical analysis of various parameters 2 months and 2 years after surgery (T3–T4)

Measurements	Mean difference	SE	<i>p</i> value	Significance
SNA	.450	.508	1.000	NS
SNB	.200	.490	1.000	NS
ANB	.250	.417	1.000	NS
Pog-Na	.200	.442	1.000	NS
CoA	1.000	.978	1.000	NS
CoGn	1.000	1.174	1.000	NS
Max-Mand	.000	.447	1.000	NS
LAFH	2.300	1.528	.999	NS
FMA	.050	.337	1.000	NS
GoGn-SN	.000	.447	1.000	NS
Jaraback	−.036	.328	1.000	NS
SN:GoPg	.003	.004	1.000	NS

Fig. 1 Frontal photograph of a representative case at **a** pre-treatment, **b** pre-surgery, **c** 2 months post-surgery and **d** 2 years post-surgery

Fig. 2 Profile photograph of same patient at **a** pre-treatment, **b** pre-surgery, **c** 2 months post-surgery and **d** 2 years post-surgery

Fig. 3 Lateral cephalogram of same patient at **a** pre-treatment, **b** pre-surgery, **c** 2 months post-surgery and **d** 2 years post-surgery

(T2–T3) revealed statistically significant improvement for all mandibular parameters with no significant change in maxillary parameters (Table 3).

The changes that occurred over a minimum time period of 2 years post-surgery (T3–T4) are presented in Table 4. Comparison of the treatment outcomes revealed that the mean relapse at pogonion was 0.2 ± 0.44 mm. Point B, mandibular corpus length, anterior and posterior facial height remained stable with no significant relapse during the follow up period. A representative case is shown in Figs. 1, 2 and 3.

Discussion

There have been a number of studies investigating skeletal relapse after mandibular advancement surgery. Early relapse has been attributed to surgical technique, whereas late relapse has been related to unbalanced forces [3]. A

gradual decrease in the length of the mandibular body due to resorptive processes at the osteotomy site (osteotomy slippage), a reduction of mandibular ramus length due to progressive condylar resorption and rotation of the proximal segment following mandibular advancement are the major factors associated with skeletal relapse [8].

The mean amount of surgical advancement in our series of patients was 5.1 ± 1.25 mm at pogonion and the mean relapse was 0.2 ± 0.44 mm (3.92 %) over a minimum 2 year follow-up period. The mean change in B point position as measured by SNB and ANB angles was also not statistically significant. Eggenberger et al. [8] reported a mean relapse of 31 %, Van Sickels [9] 6.0–8.3 %, Gassmann et al. [10] 25 %, Knaup et al. [11] 2.5–2.7 %, Mobarak et al. [12] 33 %, and Simmons et al. [13] 9.5 %. The magnitude of advancement was a major factor contributing to skeletal relapse as large advancement reduces the bony contact area and tends to generate comparatively larger and more prolonged soft-tissue tensile forces. The

range of advancement reported by these authors varied from 4.1 to 9.5 mm. However in our study the advancement was 3.5–7 mm with an average of 5.1 mm. Thus, the relapse may be directly proportional to the degree of advancement.

The present study analysed SN:GoPg ratio for evaluation of change in mandibular corpus length to determine the extent of the osteotomy slippage. The mean change in SN:GoPg ratio was statistically not significant. This is due to stable fixation of the osteotomised segments using miniplates. Epker and Wessberg [4] concluded that prolonged skeletal stabilization with control of the proximal segment is the only practical method for ensuring maximum stability. Van Sickels [9] showed that in large advancements, additional stabilization with skeletal suspension wires showed increased stabilization after 6 months. Therefore, it can be concluded from the available data that stabilization of the fragments after advancement bilateral SSRO by miniplates generally leads to predictable and stable results.

Long-term relapse is dependent on factors like condylar resorption and muscular pull and radiographic signs usually occur 6 months after surgery [5]. The amount of advancement influencing progressive condylar resorption was noted by Scheerlinck et al. [14], and that resorption was four times greater for advancements exceeding 10 mm when compared with advancements of 5–10 mm. According to some reports, condylar resorption occurs most frequently in women with a high mandibular plane angle [9, 15, 16]. The current study comprised 8 female patients with a mean pre-surgical mandibular plane angle of $18.5^\circ \pm 8.49^\circ$ and $26.0^\circ \pm 8.33^\circ$ respectively with Frankfort horizontal and anterior cranial base. Hence, our cases were horizontal growers with low mandibular plane angle. A minimal amount of remodelling of condylar and glenoid fossa occurred as evident by the fact that the Jaraback ratio was stable. This coupled with statistically non-significant change in the length of CoGn and maxillo-mandibular differential revealed no loss in vertical height of the posterior mandible due to progressive condylar resorption. Thus, it can be concluded that SSRO within the range of mandibular advancement is a stable procedure in patients with low mandibular plane angle.

In the present study the mean increase in Frankfort mandibular plane angle was $3.75^\circ \pm .85^\circ$ resulting in increase of the lower anterior facial height by 4.8 ± 1.11 mm. The treatment outcomes remained stable as there were no significant changes in these parameters during follow-up period. The studies by Douma et al. [17] and Stoelinga and Leenen [18] also reported similar findings. However, in high mandibular plane angle cases, counter clock wise rotation of the distal segment and posterior displacement of proximal fragment were associated with the increased risk of relapse [19, 20].

A thorough clinical and radiographic examination, pre-surgical and post-surgical orthodontic treatment to achieve functional occlusion, and the surgeon's skills are important factors to achieve a favourable and stable functional and aesthetic result. A careful pre-surgical orthodontic treatment is crucial for postsurgical functional occlusion. The best condylar position in the glenoid fossa intraoperatively was achieved by manual repositioning of the condylar segment by experienced oral and maxillofacial surgeon in the present study and occlusion was checked by the use of prefabricated customized splint. Post-surgical orthodontic treatment aimed at improvement of intercuspation and maintenance of the achieved surgical result. Therefore, it can be concluded that presurgical fabrication of occlusal splint using face bow transfer, duplication of pre-operative plan as determined by cephalometric tracing and model surgery on operation table and post-surgical use of splint to guide the mandible to neo-occlusion are necessary steps to minimise relapse.

SSRO advancement surgery to correct mandibular corpus deficiency is a safe technique that yields stable results over time. Relapse being multifactorial in nature, therefore some amount of relapse has to be expected. However, it can be minimized by correct diagnosis, comprehensive planning and adequate pre-surgical work-up, adherence to preoperative planning and achieving best condylar position and occlusal relationship, and maintaining results postoperatively by periodic check-ups.

Conflict of interest None.

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