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ORIGINAL ARTICLE

Transverse Changes in Mandible Following Bilateral Sagittal Split Ramus Osteotomy Advancement

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Abstract

Background BSSRO is the most frequently performed surgical procedure for mandibular advancement. However, the effect of advancement on proximal segment is not clearly understood.

Aim and Objectives The aim of the study was to evaluate the radiographic transverse changes in mandible following BSSRO advancement and to compare the amount of transverse displacement of the proximal segment with the amount of surgical advancement.

Materials and Methods Twelve cases of skeletal class II deformity undergoing fixed orthodontic mechanotherapy and requiring mandibular advancement were selected for the study. Pre-operative (T0) PA ceph and OPG were used to measure the linear distances from right to left Co–Go, Go–Me, Go–Go, Co–Co, Rp–Rp and Co–Me points. The cases were operated for BSSRO mandibular advancement. Post-operative (T1) PA ceph and OPG were used to compare the changes in linear measurements.

Result There were six male and six female patients with an average age of 19.5 years. The average mandibular advancement was 6.5 mm. Post-operative radiographic changes in transverse measurements of Go–Me, Go–Go, Co–Co, Rp–Rp and Co–Me were statistical significant. The changes in Co–Go measurements were statistically not significant. We could not establish any correlation between mandibular advancement and amount of transverse changes.

Conclusion Significant changes were noticed in transverse dimensions of mandible following BSSRO advancement in both PA ceph and OPG. The transverse changes had no clinical implication during the post-operative follow-up.

Keywords PA ceph · OPG · BSSRO · Transverse changes

Introduction

Mandibular retrognathia is a common dentofacial deformity requiring a combination of orthodontic and surgical intervention. The most frequently used surgical procedure for advancement of the mandible is bilateral sagittal split ramus osteotomy (BSSRO) [1–3]. Following BSSRO, the stabilisation of osteotomised segments was initially done using wire osteosynthesis. With the advent of better fixation devices, stable fixation of the osteotomised segments is achieved using mini-plates and screws. Ideally, the fixation system should not change the position of the proximal segment which in turn alters the glenoid–condylar relationship. However, rigid fixation increases the torque on condyles. Torqueing can create posterior open bite by deflecting the condyle from the central deep portion of the glenoid fossa to a latero-inferior or medio-inferior position [4].

Transverse changes in mandible following BSSRO advancement have been reported with standard fixation techniques [5, 6]. Increased intercondylar width is one of the significant transverse changes which may be due to rotation or tilting of the axis of the condyle or the condylar neck and rotational movement of the condyle-bearing fragment [7, 8]. The sagittal, vertical and transverse

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changes that take place in proximal segment due to the change in condylar position are very difficult to predict and prevent [9, 10]. Clinically, it may be manifested as condylar sag, relapse and occlusal discrepancies. The transverse discrepancies of the proximal segment have been studied in detail using computed tomography (CT) scans, cone beam computed tomography (CBCT), computer-generated cephalometric tracing and hand tracings using acetate papers [11–13].

The aim of this study was to evaluate the transverse changes in mandible following BSSRO advancement with stable fixation and to compare the amount of transverse displacement of the proximal segment with the amount of surgical advancement. The objectives were to radiologically identify the anatomical landmarks, quantify the radiographic linear measurements and compare them with the presurgical measurements.

Patients and Methods

This prospective study was conducted in a tertiary care teaching hospital after obtaining due permission from the institutional ethical committee. Skeletal class II patients from both the sex, between 18 and 30 years of age, undergoing fixed orthodontic mechanotherapy and requiring mandibular advancement up to 7 mm were included in the study. Systemically compromised, syndromic, Bijaw deformity, facial asymmetry, residual deformity, unwilling and cases having more than 7 mm of mandibular sagittal deficiency were excluded from the study.

The selected cases were jointly evaluated by Orthodontist and Maxillofacial surgeon. Facial and intraoral photographs were taken. Pre-operative radiographs included lateral and posteroanterior (PA) cephalogram (ceph) and orthopantomogram (OPG). Pre-operative PA cephalogram and OPG were used to measure the transverse parameters (T0). Hard tissue landmarks used were Gonion (Go), Menton (Me), Condylion (Co) and Ramal Point (Rp). Linear distances from right to left Co–Go, Go–Me, Go–Go, Co–Co, Rp–Rp and Co–Me were measured in centimetres. Each radiograph was traced by three examiners, and the mean value was taken. Upper and lower models were mounted on a semi-adjustable articulator using facebow transfer. Model surgery was carried out and surgical splint fabricated.

The cases were operated under general anaesthesia by a single orthognathic surgeon. Bilateral sagittal ramus osteotomy was carried out as modified by Hunshuk and Dalpont [14]. The distal segment was advanced, and the surgical splint was used to achieve predetermined occlusion. Intermaxillary fixation (IMF) was carried out. The position of proximal segment was manually checked to ascertain the condylar position in glenoid fossae. The osteotomised segments were stabilised using a 4-hole titanium mini-bone plate with gap and 7-mm screws. Haemostasis was achieved and wound sutured.

Post-operative care was continued as per the institutional protocol. Sutures were removed on the 7th post-operative day. The surgical splint was cemented in position for 2 weeks to guide occlusion. The patients were subjected to post-surgical orthodontic treatment.

Post-operative PA cephalogram and OPG at 4 weeks (T1) were used to assess the transverse changes and compare with pre-operative data (Figs. 1a, b, 2a, b). All radiographs were taken from single machine with same parameters to avoid any bias.

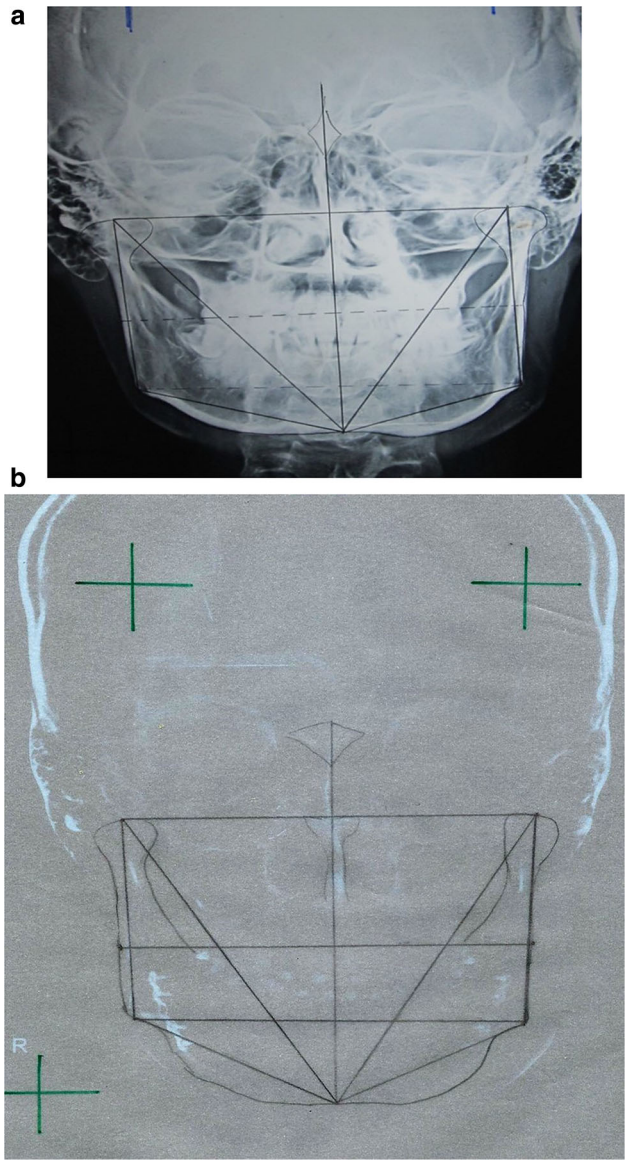

Fig. 1 **a** Pre-operative PA cephalogram, **b** post-operative PA cephalogram

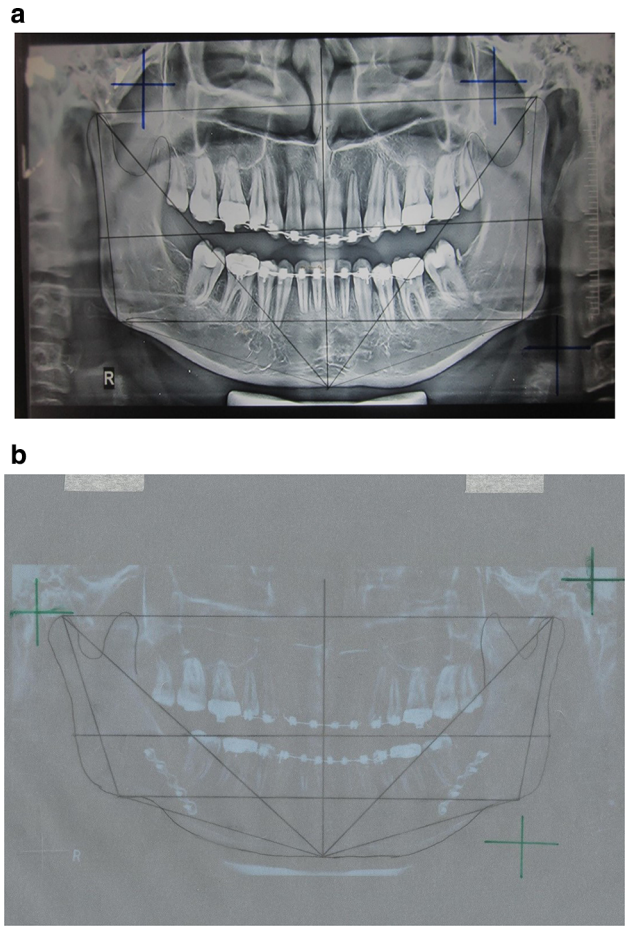

Fig. 2 **a** Pre-operative OPG, **b** post-operative OPG

Results

A total of 12 cases, six males and six females, were selected for the study. The age of the patients ranged from 18 to 24 years with a mean age of 19.5 years. The mandibular advancement achieved ranged from 06 to 07 mm with an average of 6.5 mm. The pre-operative and post-operative radiographic data were collected. The statistical analysis was carried out using paired '*T*' test, and two-tailed tests were applied for getting significance. Standard deviation and standard error of mean were calculated. *P* value less than or equal to 0.05 was considered statistically significant.

Condylion–Gonion (Co–Go)—the average measurement of right-side Co–Go on PA ceph at T0 was 6.042 cm with SD of 0.578 cm and at T1 was 5.989 cm with SD of 0.512 cm (*P* value 0.570). Similarly, for left side the average value measured at T0 was 5.969 cm with SD of 0.551 cm and at T1 was 5.978 cm with SD of 0.418 cm (*P* value 0.921). The average measurement of right-side Co–Go on OPG at T0 was 7.278 cm with SD of 0.662 cm and at T1 was 7.29 cm with SD of 0.66 cm (*P* value 0.532). On the left side at T0 was 7.32 cm with SD 0.683 cm and at T1 was 7.358 cm with SD of 0.713 cm (*P* value 0.283). The changes in Co–Go measurements were statistically not significant.

Gonion–Menton (Go–Me)—the average measurement of right-side Go–Me on PA ceph at T0 was 4.789 cm with SD of 0.384 cm and at T1 was 5.100 cm with SD of 0.591 cm (*P* value 0.002). Similarly, on the left side the average value at T0 was 4.683 cm with SD of 0.442 cm and at T1 was 4.894 cm with SD of 0.541 cm (*P* value 0.000). The average measurement of right Go–Me on OPG at T0 was 7.753 cm with SD of 0.761 cm and at T1 was 8.010 cm with SD of 0.818 cm (*P* value 0.000). On the left side at T0 value was 7.552 cm with SD 0.82 cm and at T1 7.844 cm with SD of 0.886 cm (*P* value 0.000). The changes of Go–Me measurements were statistical significant.

Gonion–Gonion (Go–Go)—the average measurement for Go–Go on PA ceph at T0 was 8.844 cm with SD of 0.785 cm and at T1 was 9.050 cm with SD of 0.803 cm (*P* value 0.003). On OPG, the measurement at T0 was 14.653 cm with SD of 1.549 and T1 was 15.081 cm with SD of 1.577 cm (*P* value 0.000). Both the values were statistically significant.

Condylion–Condylion (Co–Co)—the average measurement of Co–Co on PA ceph at T0 was 10.497 cm with SD of 0.480 cm and at T1 was 10.725 cm with SD of 0.568 cm (*P* value 0.003). The average measurement of Co–Co on OPG at T0 was 18.639 cm with SD of 0.976 cm, and at T1 it was 19.711 cm with SD of 0.992 cm (*P* value 0.000). The measurement values were statistically significant.

Ramal point–Ramal point (Rp–Rp)—the average of Rp–Rp measurement on PA ceph at T0 was 9.906 cm with SD of 0.656 cm and at T1 was 10.161 cm with SD of 0.669 cm (*P* value 0.000). The average measurement Rp–Rp on OPG at T0 was 17.939 cm with SD of 0.943 cm and at T1 was 18.622 cm with SD of 0.804 cm (*P* value 0.000). Both the values were statistically significant.

Condylion–Menton (Co–Me)—the average right-side measurement of Co–Me on PA ceph at T0 was 9.198 cm with SD of 0.693 cm and at T1 was 9.513 cm with SD of 0.506 cm (*P* value 0.000). Similarly, for left side the average value measured at T0 was 8.967 cm with SD of 0.587 cm and at T1 was 9.317 cm with SD of 0.519 cm (*P* value 0.000). The average right-side measurement of Co–Me on OPG at T0 was 12.575 cm with SD of 0.690 cm, and at T1 it was 13.219 cm with SD of 0.846 cm (*P* value 0.000). Similarly, on the left side at T0 it was 12.506 cm with SD 0.597 cm and at T1 was 12.925 cm with SD of 0.562 cm (*P* value 0.000). The changes in Co–Me measurement on both PA ceph and OPG were statistically significant.

Discussion

The significance of the transverse changes of mandible that occur after corpus advancement surgery is less studied, and its implications are less known. Its influence on the temporomandibular joint can range from adaptive changes to joint sounds and discomfort, pain to irreversible complications like condylar resorption. Systematic reviews to study effects of BSSRO advancement on temporomandibular joint found an intermediate degree of evidence and proved inconclusive [15]. In this study, we included cases requiring mandibular advancement up to 7 mm because stable results are achieved only up to 7 mm beyond which distraction osteogenesis should be carried out [16].

There are various methods to evaluate transverse changes in mandible like 3D CT scan and CBCT. We used PA ceph and OPG to analyse the short-term transverse changes in mandible following BSSRO advancement with mini-plate fixation. Post-operative radiographs were evaluated at 4 weeks so that by this time the patients have recovered from early post-operative problems like pain, swelling and restricted mouth opening and the occlusal contact of the teeth is satisfactory. Keeping in view of the radiation hazard, the frequent and long-term radiographic evaluation was declined by the ethical committee. The radiographs were used to report the linear change in transverse dimension at the level of condylar head, ramus and gonion. OPG has been found to be equally reliable as lateral cephalogram, which is routinely used in orthodontic practice, for measuring linear distances [17]. Superimposition and magnification are two major problems of radiographs. The most difficult point to identify was Condylion due to superimposition in PA ceph.

Six linear radiological parameters were used to evaluate the mandibular transverse changes. The changes in Co–Go measurements were statistically not significant because the length of proximal segment remains constant unless there is bad split. There was no bad split in our study group. Linear changes of remaining five parameters were statistically significant. The Go–Me is a sagittal measurement, and the change was due to BSSRO advancement which justifies that significant advancement of corpus length was achieved. The significant increase in Go–Go measurement indicates that transverse changes have taken place at gonial angle of mandible. Lateral flaring may be due to rigid fixation. During surgery, intermaxillary fixation (IMF) is carried out to keep the distal segment in desired occlusion, while stable fixation with proximal segment is achieved. It may create undue torque on proximal segment. The change in condylar segment may result after IMF is released, and the effect of muscle relaxants wears off. Similarly, a significant increase in Co–Co measurements is suggestive of condylar flaring or tilting of condylar axis which is least desirable. The condylar flare may result in relapse and TMJ problems. To avoid this, the proximal segment should be placed as passively as possible and clinical evaluation after fixation should be done so as to check the free condylar movements.

The change in Rp–Rp measurement is explained as an increase in transverse distance which corroborates with the intercondylar distance. The change in Co–Me measurement is due to surgical advancement of distal segment and may be due to the increase in transverse changes as condyle may be tilted outwards. In this study, we observed increased transverse changes at all three levels, that is, upper, middle and lower levels of the proximal segment.

The transverse changes of the proximal segment were quite evident in our study. The position of the proximal segment may be influenced by the amount of mandibular advancement and the method of fixation. We could not establish any correlation between mandibular advancement and amount of transverse changes. The titanium mini-plate and screws were used to achieve stable monocortical fixation. Similar or more flaring of the proximal segment has been reported with the use of lag screws [6]. Use of wire osteosynthesis and/or inter maxillary fixation (IMF) has least effect on the proximal segment.

The change in condylar position alters the glenocondylar relationship which may manifest clinically as TMJ dysfunction, condylar sag and even relapse. Condylar adaptation to altered position has been reported in the literature [18]. All our cases were clinically followed up for a period of minimum 1 year post-operatively and have successfully undergone post-surgical orthodontics treatment. No major complications were observed in this study. Two patients reported paraesthesia over the distribution of mental nerve which recovered over a period of 6 months.

Conclusion

BSSRO advancement of mandibular corpus is associated with unpredictable changes in the proximal segment. In this study, significant changes were noticed in transverse dimensions in both PA cephalogram and OPG. Radiological transverse changes had no clinical implication as the patients were symptom-free during the post-surgery follow-up. We followed the patients clinically for 1 year till the orthodontic treatment was completed. Immediate post-

surgical changes may get remodelled in long term due to the adaptive capacity of TMJ.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

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