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ORIGINAL ARTICLE

Evaluation of Cephalometric Changes and Its Relation to Changes in Patients' Quality of Life After Mandibular Setback Surgery

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Abstract
Purpose To find out if a relationship exists between the different cephalometric changes and the perception of patients before and after Bilateral Sagittal Split Osteotomy (BSSO) setback surgery.
Patients and Methods Sample consisted of 28 patients (mean age 23.78 ± 1.36 years), Male:Female = 1:1.3, with a median follow-up of 10 ± 1.8 months, with skeletal class III malocclusion treated with BSSO setback surgery. Pre- and post-surgery lateral cephalograms were analysed. The Oral Health Impact Profile (OHIP) questionnaire was used to assess the patients' quality of life after surgery. Cephalometric data were then correlated with the questionnaire results.
Results The psychological and social aspects of OHIP questionnaire were most affected. The most significant correlation between OHIP score change and cephalometric parameters was found with reduction of 'lower lip protrusion'; and significantly positive correlations were with increase in ANB angle and reduction in values of SND angle, N-B distance, lower lip length, lower facial height, mentolabial angle and angle of facial convexity.
Conclusions A significant relationship exists between the subjective and objective parameters which should be considered while planning for orthognathic surgery. Results of this study could be beneficial, helping the clinicians, to emphasise on specific cephalometric variable with the patient-specific expectations.

Keywords Orthognathic surgery · Quality of life · Cephalometric changes

Introduction

The marvel of the human mind is the ability to perceive, and self-perception strengthens the self-esteem. Ironically, a physical deformity of the body may cloud the self-esteem and affect the mental well-being of an individual. Dentofacial deformities are more likely to cause low self-esteem. In such cases, orthognathic surgery, which is performed by a maxillofacial surgeon in conjunction with an orthodontist, may be the blessing, the individual desires. The primary objective of these surgeries is to create satisfaction functionally, aesthetically and psychologically [1]. Facial disfigurement has a negative effect on many aspects of life. These include personality characteristics, social interactions and acceptance, opportunities, choice of profession and even marriage proposals [2]. In an attempt to correct the facial deformity and to make the face more socially acceptable, orthodontic treatment in growing age and orthognathic surgery along with orthodontic treatment (pre- and post-surgery) in adult patients is the policy of the management [3]. For this reason, specialized cephalometric appraisal systems have been developed which describe dental, skeletal and soft tissue variations and aid in treatment planning [4, 5]. However, it has been observed that the expectations of a patient out of an orthognathic procedure are somewhat different from the targeted treatment

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outcomes from a surgeon's point of view. These 'objective goals' that guide the clinician are derived from a certain normal range of cephalometric values and 'subjective goals' are the expectations that the patients are holding on to, leading to improvements in their quality of life (QoL) [6]. One of the most widely used tool to assess the QoL is Oral Health Impact Profile (OHIP-14) questionnaire [7].

The aim of this study was to assess the relationship between the objective and subjective measures, i.e. cephalometric changes with patient's QoL, thus, helping the clinicians to improve patients' QoL following orthognathic surgery by considering effective soft and hard tissue variables.

Materials and Methods

Patients

The study sample consisted of 28 individuals diagnosed with skeletal class III malocclusion showing mandibular prognathism. Their mean age was 23.78 ± 1.36 years and ranged from 21 to 26 years having a median age of 23.5 years. Skeletal growth was complete in all the patients. The Male:Female ratio was 1:1.3. All of them reported to our institution with a chief complaint of forwardly positioned lower jaw. Accordingly, they initially underwent pre-surgical orthodontic decompensation for a period ranging from 6 months to 1 year. After that, they were referred back to the Department of Oral and Maxillofacial Surgery, where they were treated with mandibular setback by Bilateral Sagittal Split Osteotomy (BSSO). Intermaxillary fixation with interocclusal wafer was continued for 2 weeks post-surgically. This was followed by post-surgical orthodontic management. Exclusion criteria were as follows: patients with any craniofacial syndrome, cleft, post-traumatic deformity, temporomandibular diseases, known metal allergy or foreign body sensitivity.

Lateral Cephalometry

Pre-surgical lateral cephalogram and 6-month post-surgical lateral cephalogram were taken for all the patients positioned in natural head position (NHP) and jaws in centric relation. The X-ray tube was positioned 150 cm from the film, and the distance from film to mid-sagittal plane was 18 cm. The cephalograms were traced manually in Glazed acetate sheet with 4H lead pencil and analysed with the Burstone and Legan method. Double tracing of the lateral cephalograms was done to avoid bias and errors. The horizontal reference line used in this study was the line with 7 degrees of difference to the sella-nasion line, and a line perpendicular to this at nasion was used as the vertical reference line. Five angular parameters (SND, ANB, angle of facial convexity, mentolabial angle, nasolabial angle) and six linear parameters (lower lip protrusion, upper lip length, lower lip length, lower facial height, nasion perpendicular to point A, nasion perpendicular to point B) were selected to compare the dentoskeletal characteristics of pre- and post-surgical cephalograms of these patients (Fig. 1).

Questionnaires

To assess the patients' QoL after surgery, the OHIP questionnaires were used. In specific, the Persian version of the short form (14 itemed) of the Oral Health Impact Profile questionnaire (OHIP-14) (Table 1) was used, which has seven domains (and two items per domain): functional limitation, physical disability, psychological disability, physical pain, psychological discomfort, social disability, and handicap. The response to each item was scored on a 5-point scale as never (0) to very often (4) and a higher score indicated poorer QoL. All the patients filled the questionnaires both pre-surgically and 6-months post-surgically.

Result

Statistical Analysis

Statistical analysis was performed with the help of Epi Info (TM) 7.2.2.2. EPI INFO is a trademark of the Centres for Disease Control and Prevention (CDC). Descriptive statistical analyses were performed to calculate the means with corresponding standard deviations (s.d.). *T* test was used to compare the means. $p < 0.05$ was taken to be statistically significant, and $p < 0.001$ was taken to be highly significant. The correlation between quality of life scores taken before and after surgery along with changes seen in both hard and soft tissues was done by Pearson's correlation analysis. Cross-checking of the tracings were done by another examiner and were evaluated by t test which showed no significant errors.

Patients

The prospective study sample consisted of 28 patients undergoing BSSO for mandibular setback (mean age 23.78 ± 1.36 years), Male:Female = 1.0:1.3; (16 female and 12 male patients). The follow-up period between pre-surgical and post-surgical evaluation was 10 ± 1.8 months. The changes in cephalometric parameters and OHIP item scores showed neither gender association nor association with socio-economic status.

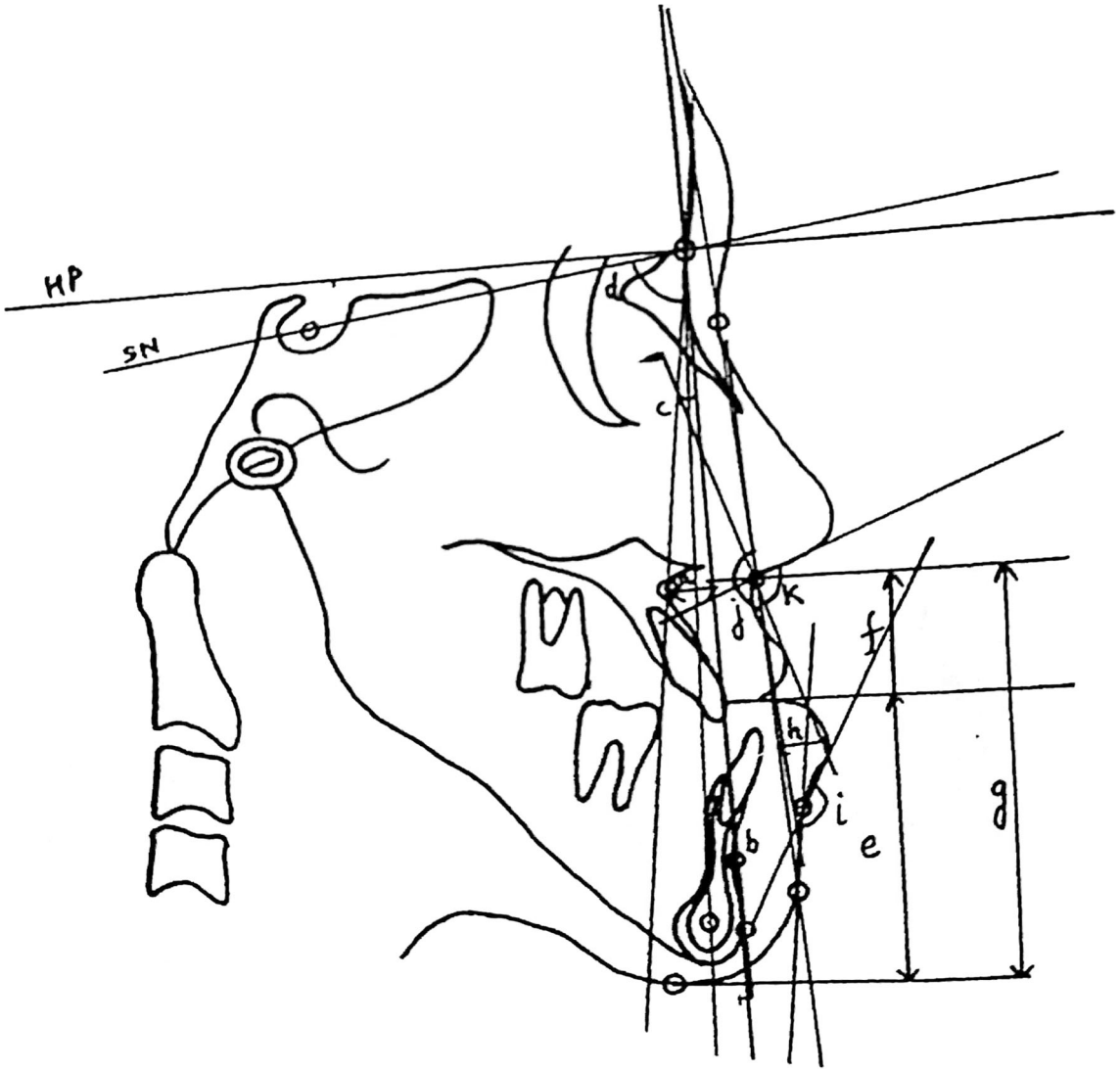

Fig. 1 Hard and soft tissue landmarks and reference lines. **a** Nasion perpendicular to point A, **b** Nasion perpendicular to point B, **c** ANB, **d** SND, **e** lower lip length, **f** upper lip length, **g** lower facial height, **h** lower lip protrusion, **i** mentolabial angle, **j** angle of facial convexity, **k** Nasolabial angle

Changes in Cephalometric Variables (Table 2)

Following BSSO setback procedures in patients with Class III skeletal jaw relation, increase in ANB angle and reduction in values of angle of facial convexity and mentolabial angle showed most significant change followed by reduction in values of N-B distance, SND angle, lower lip length, lower facial height and lower lip protrusion (all with $p < 0.0001$). There was no significant change in values of N-A distance, upper lip length and nasolabial angle ($p > 0.05$).

Changes in OHIP Scores (Table 3)

The mean of all the OHIP-14 item scores decreased significantly after surgery as compared to before surgery ($p < 0.0001$) except for OH2, OH3, OH7, OH8 and OH14, which decreased but it was not significant ($p > 0.05$). The psychological and social aspects of OHIP questionnaire were most affected followed by the functional aspect.

Correlations Between Changes in Cephalometric Variables and OHIP Score Change (Tables 4 and 5)

The post-surgical reduction of the N-B distance, SND angle, lower lip length, lower lip protrusion, lower facial

Table 1 OHIP 14 items

OH-01	Have you had trouble pronouncing any words because of problems with your teeth, mouth, or dentures?
OH-02	Have you felt that your sense of taste has worsened because of problems with your teeth, mouth, or dentures?
OH-03	Have you had painful aching in your mouth?
OH-04	Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth, or dentures?
OH-05	Have you felt self-conscious because of problems with your teeth, mouth, or dentures?
OH-06	Have you felt tense because of problems with your teeth, mouth, or dentures?
OH-07	Has your diet been unsatisfactory because of problems with your teeth, mouth, or dentures?
OH-08	Have you had to interrupt meals because of problems with your teeth, mouth, or dentures?
OH-09	Have you found it difficult to relax because of problems with your teeth, mouth, or dentures?
OH-10	Have you been a bit embarrassed because of problems with your teeth, mouth, or dentures?
OH-11	Have you been a bit irritable with other people because of problems with your teeth, mouth, or dentures?
OH-12	Have you had difficulty doing your usual job because of problems with your teeth, mouth, or dentures?
OH-13	Have you felt that life in general was less satisfying because of problems with your teeth, mouth, or dentures?
OH-14	Have you been totally unable to function because of problems with your teeth, mouth, or dentures?

Scores: 0 (Never), 1 (Hardly Ever), 2 (Occasionally), 3 (Very Often), 4 (Fairly Often)

Table 2 Comparison of cephalometric values of the patients before and after the surgery

Cephalometric values	Pre-surgery (n = 14) (Mean ± sd)	Post-surgery (n = 14) Mean ± sd	t test (t_{26})	p value
N-A (mm)	− 1.52 ± 1.39	− 1.52 ± 1.39	0.01	0.99 NS
N-B (mm)	0.96 ± 1.07	− 4.55 ± 1.14	13.156	< 0.0001*
ANB (°)	− 7.51 ± 0.90	− 0.89 ± 1.13	17.094	< 0.0001*
SND (°)	81.36 ± 0.99	77.84 ± 0.84	10.141	< 0.0001*
Lower lip length (mm)	43.99 ± 1.44	40.75 ± 0.95	7.001	< 0.0001*
Upper lip length (mm)	18.76 ± 0.63	18.79 ± 0.60	0.154	0.879 NS
Lower lip protrusion (mm)	8.32 ± 0.51	5.64 ± 0.49	14.133	< 0.0001*
Lower facial height (mm)	63.24 ± 1.50	60.10 ± 1.21	6.087	< 0.0001*
Mentolabial angle (°)	160.51 ± 2.64	153.69 ± 2.77	6.659	< 0.0001*
Angle of facial convexity (°)	177.59 ± 2.93	169.19 ± 2.82	7.730	< 0.0001*
Nasolabial angle (°)	92.81 ± 1.13	92.90 ± 1.27	0.205	0.839 NS

NS statistically not significant

*Statistically significant

height, mentolabial angle and angle of facial convexity showed significant positive correlation with QoL, of which the lower lip protrusion was most strongly correlated. Lower lip protrusion was found to be most significantly positively correlated with OHIP scores OH5 (r = 0.595), OH6 (r = 0.565), OH10 (r = 0.582), OH13 (r = 0.538). Post-surgical increase in ANB angle was positively correlated with QoL. Correlations of N-A distance, upper lip length and nasolabial angle with the OHIP item scores were insignificant.

Discussion

Dentoskeletal Class III malocclusion results in unaesthetic alterations of soft tissues, which may cause psychological and interpersonal problems [8]. Therefore, it seems reasonable to offer orthognathic surgery to subjects with dentofacial deformities to improve their psychological well-being and QoL. Earlier, patients used to undergo post-surgical depression generally due to inability to accept the change in their face with which they were accustomed. Over the time, it came in focus that what an orthodontist or a surgeon finds beautiful or attractive on the basis of their planning and experience may not be same as the patient's opinion [9]. There are various factors affecting the patient's QoL like better communication between clinician and

Table 3 Comparison of OHIP-14 item scores of the patients before and after the surgery

OHIP-14 item scores	Pre-surgery (n = 14) (Mean ± sd)	Post-surgery (n = 14) Mean ± sd	t test (t_{26})	p value
OH1	3.50 ± 0.52	0.36 ± 0.50	16.363	< 0.0001*
OH2	0.21 ± 0.43	0.00 ± 0.00	1.883	0.082 NS
OH3	0.50 ± 0.52	0.07 ± 0.27	1.747	0.13 NS
OH4	2.79 ± 0.43	0.00 ± 0.00	24.478	< 0.0001*
OH5	3.79 ± 0.43	0.00 ± 0.00	33.265	< 0.0001*
OH6	3.71 ± 0.47	0.07 ± 0.27	25.258	< 0.0001*
OH7	0.36 ± 0.50	0.07 ± 0.27	1.894	0.073 NS
OH8	0.21 ± 0.43	0.00 ± 0.00	1.883	0.082 NS
OH9	2.43 ± 0.51	0.14 ± 0.36	13.597	< 0.0001*
OH10	3.79 ± 0.43	0.14 ± 0.36	24.356	< 0.0001*
OH11	2.43 ± 0.51	0.14 ± 0.36	13.597	< 0.0001*
OH12	1.64 ± 1.01	0.07 ± 0.27	5.637	< 0.0001*
OH13	1.43 ± 0.76	0.06 ± 0.27	6.333	< 0.0001*
OH14	0.71 ± 0.47	0.04 ± 0.27	1.457	0.22 NS

NS statistically not significant

*Statistically significant

Table 4 Correlation between differences of pre- and post-operative linear parameters and OHIP-14 item scores of the patients

OHIP(14) ITEMS	N-A	N-B	Lower lip length	Upper lip length	Lower lip protrusion	Lower facial height
OH1	ns	ns	ns	ns	ns	ns
OH2	ns	ns	ns	ns	ns	ns
OH3	ns	ns	ns	ns	ns	ns
OH4	ns	ns	ns	ns	ns	ns
OH5	ns	**0.568***	ns	ns	**0.595***	ns
OH6	ns	ns	**0.613***	ns	**0.565***	ns
OH7	ns	ns	ns	ns	ns	ns
OH8	ns	ns	ns	ns	ns	ns
OH9	ns	ns	ns	ns	**0.560***	ns
OH10	ns	ns	ns	ns	**0.582***	ns
OH11	ns	ns	0.569*	ns	ns	ns
OH12	ns	ns	ns	ns	ns	ns
OH13	ns	ns	ns	ns	**0.538***	**0.547***
OH14	ns	ns	ns	ns	ns	ns

Bold characters denote the significant parameters

ns Statistically not significant

*Statistically significant

patient, post-operative complications [10]. In our study, the patients were well informed about the complete treatment and also the patients with post-operative complications like infections, malunions, etc. were excluded from the study; thus making this study more reliable, eliminating the effect of these variable factors on QoL of patients. The quantification of patient-centred evaluation, i.e. evaluation of QoL after orthognathic procedures led to popularization of questionnaires for measuring QoL. There are various questionnaires but with the more generic OHIP-14 for oral health, a larger effect size was revealed [11, 12]. Hence, in our study, we used OHIP-14 Questionnaire.

It has been observed that women showed improved self-esteem and diminished depressive symptoms after surgical intervention, whereas men showed no alteration [13]. However, we did not find any association with gender and QoL outcomes, which concurred with the findings of other similar studies [14].

Table 5 Correlation between differences of pre- and post-operative angular parameters and OHIP-14 item scores of the patients

OHIP(14) ITEMS	ANB	SND	Mentolabial angle	Angle of facial convexity	Nasolabial angle
OH1	ns	ns	ns	0.588*	ns
OH2	ns	ns	ns	ns	ns
OH3	ns	ns	ns	ns	ns
OH4	ns	ns	ns	ns	ns
OH5	**0.505***	**0.563***	ns	ns	ns
OH6	ns	ns	**0.514***	ns	ns
OH7	ns	ns	ns	ns	ns
OH8	ns	ns	ns	**0.531***	ns
OH9	0.560*	ns	ns	**0.526***	ns
OH10	ns	ns	**0.583***	ns	ns
OH11	**0.706***	**0.659***	**0.669***	ns	ns
OH12	ns	ns	ns	**0.620***	ns
OH13	ns	ns	**0.549***	ns	ns
OH14	ns	ns	ns	ns	ns

Bold characters denote the significant parameters

ns Statistically not Significant

*Statistically significant

No significant changes in mentolabial fold thickness (mm) after orthognathic surgery in class III malocclusion patients was observed [15]. On the contrary, in the present study, changes in mentolabial area were assessed by mentolabial angle instead of mentolabial fold thickness and a significant change in mentolabial angle was seen in most of the cases. In BSSO setback procedures, changes in SND angle, ANB angle, N-B distance and angle of facial convexity are indicators of amount of sagittal mandibular setback and in our study, correction of deformity by improving these parameters played an important role in increasing QoL, which is in great agreement with other studies [16]. Protrusive lower lip reduces the attractiveness of person in general [17]. Our study also showed a significant relationship of the reduction in lower lip protrusion with the QoL.

A more significantly positive correlation was observed between mentolabial angle and OHIP scores involving psychological discomfort (OH6, 10), social disability (OH-11), handicap (OH-13) and also between N-B distance and OH-5 in our study, which is in accordance with the similar studies [5]. In the present study, reduction of the facial convexity angle, lower lip length and lower facial height revealed positive correlations, with changes in scores of the items, which is in contrast to previous studies [5].

Angle of facial convexity was more positively correlated with OH 1, OH 8, OH 9, OH 12; lower facial height with OH13; lower lip length with OH6, OH1. Lower lip protrusion is found to be most significantly positively correlated with OHIP scores (OH5, OH6, OH9, OH10, OH13). It may be explained as the patients undergoing orthognathic surgery are seen to be embarrassed of their prominent lip before treatment, which improves after surgery leading to a high improvement in QoL.

No significant relation of nasolabial angle, N-A distance and upper lip protrusion was found with the QoL, in contrast to other studies [18].

As a good increase in the QoL is expected from orthognathic surgeries, attention to the parameters affecting the patients' QoL is essential, particularly in treatment planning. Emphasis on specific variables during treatment planning could improve patients' QoL more.

It needs to be mentioned that this study would have been complete in all senses by considering the changes in profile and frontal views of the face along with the hard and soft tissue changes in cephalograms. Also, a larger sample size and a longer follow-up period may give more reliable results.

Conclusions

Significant correlations were found between changes in cephalometric parameters and item scores in the OHIP-14 questionnaire. It is undeniable that considering the subjective and objective parameters during preparing the patients to their new appearance are necessary.

Declarations

Conflict of interest There are no conflicts of interest.

Ethical Approval All procedures performed in this study were in accordance with the institutional ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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