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Changes in the Gonial Angle Following Bimaxillary Osteotomy

Farnoosh Mohammadi [1,2], Mohammadsadegh Safarian [3*]

1. Department of Oral and Maxillofacial Surgery, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.
2. Craniomaxillofacial Research Center, Tehran University of Medical Sciences, Tehran, Iran.
3. Department of Oral and Maxillofacial Surgery, School of Dentistry, Ilam University of Medical Sciences, Ilam, Iran.

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**Corresponding author:*
Mohammadsadegh Safarian

Department of Oral and Maxillofacial Surgery, School of Dentistry, Ilam University of Medical Sciences, Ilam, Iran.

Tel: +98-939-9778394
Fax: 021-84903747
Email: msafarian99@gmail.com

ABSTRACT

Introduction: The aim of this study was to evaluate changes in the gonial angle (GA) after bilateral sagittal split ramus osteotomy (BSSRO) combined with Le Fort I osteotomy in Class II and Class III patients, and to compare the outcomes between the two groups.

Materials and Methods: In this retrospective cohort study, 48 patients (21 Class II, 27 Class III) from Tehran University of Medical Sciences were included. All patients underwent bimaxillary osteotomy with rigid internal fixation using miniplates. Lateral cephalograms were used to measure the GA and occlusal plane angle (OPA) preoperatively, one day postoperatively, and 12 months postoperatively. Changes were analyzed using paired t-tests within groups and independent t-tests between groups. Pearson's correlation was used to assess the relationship between GA and OPA changes.

Results: The mean reduction in GA at 12 months was 2.81° (±2.89°) in Class II and 3.81° (±2.60°) in Class III patients. The mean relapse (increase) in GA from the first postoperative day to 12 months was 1.57° (±1.60°) in Class II and 2.00° (±1.41°) in Class III patients. No statistically significant difference was found between the two groups for the magnitude of GA change or relapse ($p > 0.05$). Furthermore, no significant correlation was found between the amount of GA change and OPA change within either group ($p > 0.05$).

Conclusion: Bimaxillary osteotomy with rigid fixation resulted in a significant reduction of the gonial angle in both Class II and Class III patients. Although the magnitude of change and relapse was numerically greater in Class III patients, the difference was not statistically significant. The occlusal plane angle changed in a similar direction but was not strongly correlated with the gonial angle change.

Keywords: BSSO; Gonial angle; Occlusal plane angle; Bimaxillary osteotomy; Miniplate fixation.

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Introduction

The gonial angle (GA) is a key determinant of a harmonious facial appearance, particularly in the lower third of the face [1]. In mandibular prognathism (Class III), an obtuse GA is a common feature, and its correction is a desired outcome of orthognathic surgery [2]. Accurate prediction of hard tissue changes, including the GA, is crucial for treatment planning [3]. Previous studies have primarily evaluated GA changes following mandibular-only procedures, such as bilateral sagittal split osteotomy (BSSO) or intraoral vertical ramus osteotomy (IVRO), often using non-rigid fixation (wires) and maxillomandibular fixation [4-6]. These studies, focused on Class III patients, reported GA reductions ranging from 2° to over 7° [4-6]. There is a paucity of data on GA changes in Class II patients undergoing bimaxillary surgery. Furthermore, the effect of modern rigid internal fixation with miniplates on GA stability in a bimaxillary context is not well-documented. This study aims to evaluate and compare the changes and relapse of the gonial angle following bimaxillary osteotomy (BSSO and Le Fort I) with miniplate fixation in patients with Class II and Class III skeletal deformities. A secondary aim is to assess the relationship between changes in the GA and the occlusal plane angle (OPA).

Materials and Methods

Study Design and Participants: This retrospective cohort study was approved by the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.DENTISTRY.REC.1397.005). The study analyzed records of 48 patients (16 male, 32 female) who underwent bimaxillary orthognathic surgery. The sample included 21 patients with Class II and 27 patients with Class III skeletal deformities. Patients with syndromic conditions, a history of facial trauma, or previous orthognathic surgery were excluded. Surgical Procedure: All surgeries were performed by the same surgical team.

Each patient underwent a Le Fort I osteotomy of the maxilla and a bilateral sagittal split ramus osteotomy (BSSO) of the mandible. Rigid internal fixation was achieved using titanium miniplates: two plates per side for the maxilla and one plate per side for the mandible. Good bone contact was confirmed at fixation. Postoperative orthodontic management, including the use of guiding elastics as needed, was employed to maintain a stable Class I occlusion throughout the follow-up period. Cephalometric Analysis: Standardized lateral cephalograms were obtained at three time points: preoperatively (T0), one day postoperatively (T1), and 12 months postoperatively (T2). The gonial angle (GA) and the occlusal plane angle (OPA) were traced and measured by a single calibrated investigator. The GA was defined as the angle between the tangents to the lower border of the mandible and the posterior border of the ramus. The OPA was defined as the angle between the functional occlusal plane and the Frankfort horizontal plane.

Statistical Analysis

Data were analyzed using SPSS version 25 (IBM Corp.). Descriptive statistics (mean, standard deviation) were calculated. Paired t-tests were used to compare T0-T1 (surgical change) and T1-T2 (relapse) measurements within each group. Independent t-tests were used to compare the magnitude of GA change and relapse between the Class II and Class III groups. Pearson's correlation coefficient was calculated to assess the relationship between the change in GA and the change in OPA within each group. A p-value of < 0.05 was considered statistically significant.

Results

The descriptive data for GA and OPA at all time points are presented in Table 1. In Class II patients, the mean GA decreased significantly from 127.10° preoperatively to 122.71° immediately after surgery ($p < 0.001$), indicating a surgical reduction of 4.39°. At 12 months, it relapsed to 124.29°, resulting in a net reduction of 2.81° from baseline. The mean relapse from T1 to T2 was 1.57°. In Class III patients, the mean GA decreased significantly from 129.78° to 123.96° postoperatively ($p < 0.001$), a reduction of 5.82°. At 12 months, it relapsed to 125.96°, yielding a net reduction of 3.81° from baseline. The mean relapse from T1 to T2 was 2.00°. Comparison between Groups: An independent t-test revealed no statistically significant difference between Class II and Class III patients in the net GA reduction at 12 months ($p = 0.21$) or in the magnitude of relapse ($p = 0.32$). While the Class III group showed greater numerical changes, the differences were not statistically significant. Correlation between GA and OPA: In both groups, the OPA decreased postoperatively and exhibited a slight increase at follow-up, mirroring the direction of GA change (Table 2). However, Pearson's correlation analysis found no statistically significant correlation between the absolute amount of change in GA and the change in OPA from T0 to T2 in either the Class II group ($r = 0.28$, $p = 0.21$) or the Class III group ($r = 0.19$, $p = 0.35$).

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Table 1. The mean values of the GA and OPA before, one day and one year after the surgery in Class II and Class III groups.

Descriptive Statistics						
Occlusion		N	Minimum	Maximum	Mean	Std. Deviation
2	age	21	18	28	20.38	2.801
	occl.bef	21	5	27	18.38	5.201
	gon.bef	21	111	147	127.10	9.016
	occl.aft	21	4	21	14.86	4.281
	gon.aft	21	110	138	122.71	6.451
	occl.fol	21	5	22	16.00	4.207
	gon.fol	21	111	141	124.29	7.121
	Valid N (listwise)	21				
3	age	27	17	29	20.48	3.227
	occl.bef	27	0	30	18.48	6.290
	gon.bef	27	112	142	129.78	7.827
	occl.aft	27	0	25	16.22	5.522
	gon.aft	27	108	136	123.96	6.931
	occl.fol	27	0	26	16.93	5.595
	gon.fol	27	110	138	125.96	7.219
	Valid N (listwise)	27				

Table 2. The mean values of changes in the GA and OPA, one day after the surgery (occl.surg and gon.surg) and from one day to one year after the surgery (gon.rel and occl.rel) in Class II an Class III groups. (gon.gain) and (occl.gain) showed the changes in the GA and OPA from before the surgery to the follow-up time.

Occlusion		N	Minimum	Maximum	Mean	Std. Deviation
2	occl.rel	21	-1.00	2.00	1.1429	1.01419
	gon.rel	21	-3.00	4.00	1.5714	1.59911
	occl.surg	21	-11.00	1.00	-3.5238	3.05972
	gon.surg	21	-12.00	5.00	-4.3810	4.35289
	occl.gain	21	-9.00	0.00	-2.3810	2.29077
	gon.gain	21	-8.00	2.00	-2.8095	2.89170
	Valid N (listwise)	21				
	occl.rel	27	-4.00	2.00	0.7037	1.35348
	gon.rel	27	-2.00	6.00	2.0000	1.41421
3	occl.surg	27	-7.00	6.00	-2.2593	2.55091
	gon.surg	27	-13.00	1.00	-5.8148	3.06390
	occl.gain	27	-5.00	2.00	-1.5556	1.45002
	gon.gain	27	-11.00	0.00	-3.8184	2.60232
	Valid N (listwise)	27				

Discussion

This study demonstrates that bimaxillary osteotomy with rigid internal fixation effectively reduces the gonial angle in patients with both Class II and Class III dentofacial deformities. The mean reduction of 3.81° in Class III patients aligns with the range reported in studies using rigid fixation, which typically show less change than studies employing wire osteosynthesis and prolonged maxillomandibular fixation [4-6]. This supports the hypothesis that fixation method influences the magnitude of bony segment displacement and subsequent angular change. The novel finding of a 2.81° reduction in Class II patients confirms that the surgical-orthodontic approach can also modify mandibular morphology in this population, where an obtuse GA may contribute to the aesthetic imbalance. The lack of a statistically significant difference in outcomes between the two groups suggests that the biomechanical effect of the bimaxillary procedure on the proximal mandibular segment is similar, despite differences in the direction of jaw movement. The numerically greater change and relapse in Class III patients may be attributed to their significantly higher preoperative GA and the potentially larger surgical movements involved in mandibular setback.

The observed directional concordance between GA and OPA changes is likely related to the integrated nature of bimaxillary surgery and postoperative occlusal management. However, the absence of a statistically significant correlation indicates that these angles are influenced by multiple independent factors, such as the specific surgical plan (e.g., autorotation), muscular forces, and individual healing patterns [11]. The use of rigid fixation and active postoperative orthodontics to maintain occlusion is likely a key factor in controlling the final skeletal and occlusal relationships [12,13]. Limitations of this study include its retrospective design and the lack of long-term follow-up beyond 1 year. Furthermore, the sample size, while adequate for initial comparison, may have been underpowered to detect smaller inter-group differences.

Conclusion

Within the limits of this study, bimaxillary osteotomy with rigid miniplate fixation significantly reduces the gonial angle in both Class II and Class III patients. No statistically significant difference was found in the extent of change or relapse between the two skeletal classes, although a trend toward greater change was noted in Class III patients. Changes in the occlusal plane occurred in a similar direction but were not strongly correlated with changes in the gonial angle. These findings should be integrated into preoperative planning for patients where modification of the mandibular angle is a treatment objective.

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Conflict of Interest

There is no conflict of interest to declare.

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