

Does Mandibular Advancement Orthognathic Surgery Lead to TMJ Dysfunction in Skeletal Class 2 Patients? A Quasi-Experimental Trial in an Iranian Population

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ABSTRACT

BACKGROUND

We aimed to evaluate the possibility of temporomandibular joint (TMJ) dysfunction following mandibular advancement surgery in skeletal class 2 patients.

Methods: All healthy non-syndromic patients with Class 2 deformity, who were eligible for mandibular advancement surgery, were included in this before-after quasi-experimental study. The main intervention was mandibular advancement through bilateral sagittal split osteotomy (BSSO). Maxillary impaction or setback surgery using LeFort 1 osteotomy was simultaneously performed in some cases. Variables such as TMJ pain, clicking, crepitus, or any other type of sounds or complaint as well as the amount of maximum mouth opening (MMO) were evaluated before surgery and two months postoperatively.

Results: Thirty patients including 15 men and 15 women with a mean age of 23.3 ± 2.7 yr were studied. The mean amount of mandibular advancement displacement was 3.30 ± 0.87 mm. The rate of TMJ dysfunctions and complaints was relatively low two months postoperatively when compared to the preoperative state. Postoperative evaluation demonstrated that there was no significant correlation between the presence of TMJ symptoms and dysfunctions and the type of surgery. After treatment was completed, the mean MMO reduced significantly from 39.03 ± 5.86 to 38.12 ± 6.05 ($P < 0.001$).

Conclusion: Mandibular advancement with BSSO surgery in skeletal class 2 patients did not clinically lead to TMJ dysfunctions. Among all the investigated factors, only preoperative pain, noises, or complaints were proven to have predictive value for postoperative TMJ dysfunction.

Keywords: Orthognathic surgery; Skeletal class 2; Mandibular advancement; TMJ dysfunction

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INTRODUCTION

The effect of orthognathic surgery on the temporomandibular joint (TMJ) is one of the important points in maxillofacial surgeries^{1,2}. Determining the condyle location as well as the relation between the disk and the condyle is a key factor in orthognathic surgery, to prevent further TMJ problems, which can eventually lead to skeletal relapse³⁻⁵.

Although the majority of oral and maxillofacial surgeons evaluate their orthognathic surgery success based on postoperative esthetics and patient satisfaction; functional rehabilitation is of much more importance. The temporomandibular joint is the key to occlusion and any intervention, which has a direct or indirect potential effect on the TMJ components, can highly impact one's quality of life^{2,4,6,7}.

Before developing an appropriate treatment plan for patients with jaw discrepancies, assessment of the TMJ and evaluating all influential biomechanical and biochemical factors in the TMJ function is deemed necessary^{4,6,8}. Orthognathic surgery may lead to morphologic changes in the TMJ. In some instances, absolutely no change is observed, while adaptive changes and degenerative TMJ changes can also be a possible response to these surgeries⁹. Temporomandibular disease (TMD) is of multifactorial and complex etiology with multiple physical and psychosocial factors contributing to this condition. The patient's metabolic and psychological status is effective predisposing factors for TMD. Repeated trauma and mechanical overload are assumed to be initiating factors and parafunctional habits are an example of intensifying factors^{7,10,11}.

Due to the nature of orthognathic surgery procedures, a major alteration in the condylar position occurs, leading to morphologic changes of the mandibular condyles. Mandibular advancement with or without concomitant maxillary procedures is widely performed and improves masticatory function and esthetic in candidate patients⁹. Following the orthognathic surgeries, multiple postoperative dysfunctions concerning the TMJ area have been stated in the literature; condylar resorption, clicking and crepitus, mandibular deviation, increased pain and discomfort along restricted mouth opening^{12,13}. Nevertheless, the limitations and diversity in the conducted studies should not be overlooked. On

the other hand, patients manifest a variety of TMJ alterations after mandibular advancement surgery, which can differ from person to person. Therefore, it remains controversial whether or not mandibular advancement can impair the TMJ^{2,3,14-18}.

Published systematic reviews upon this matter lack sufficient evidence and are not reliable enough to draw a definite conclusion^{3,4,19,20}. To date, limited researches have been done to assess the effects of mandibular advancement on TMJ dysfunction, among the Iranian population. Hence, the purpose of this study was to determine the prevalence of pain, discomfort, clicking and crepitus in the TMJ area prior to mandibular advancement in comparison to two months postoperatively, and to assess how it affects the maximum mouth opening (MMO).

METHODS

The protocol of this quasi-experimental, before-after trial was approved by the Research and Ethics Committee of Mashhad University of Medical Sciences (IR.mums.sd.REC.1394.288). Guidelines of the declaration of Helsinki and Consort statement were followed in this research and patients were recruited only after obtaining fully informed consent.

The study population consisted of patients with skeletal class 2 deformities requiring mandibular advancement with or without maxillary setback admitted to the Oral and Maxillofacial Surgery Department of Mashhad Dental School and Ghaem Hospital, Mashhad Iran, from 2018 to 2020. Inclusion criteria were patients aged over 18 yr and classified as ASA 1 or 2, for which orthodontic treatment had been initiated and was prepared to undergo orthognathic surgery. Patients with severe skeletal or soft tissue discrepancies as well as those who experienced postoperative complications during their hospitalization period were excluded from this study. In cases of incomplete follow-up visits, the patient was to be omitted from the study. However, patients reporting minor discomforts in the TMJ area, such as clicking or other sounds and those with only a slightly reduced maximum mouth opening remained part of the study population. All of the patients underwent mandibular advancement by BSSO (bilateral sagittal split osteotomy) technique in the same hospital, with the same surgery protocols and the surgery was

performed by the same operative team for each patient. The necessary preoperative assessments were carefully documented and mandibular advancement was performed for all consecutive patients. Whereas some patients' treatment plan also included maxillary setback or maxillary impaction surgery accomplished by LeFort I osteotomy. In order to prevent probable postoperative infection, prophylactic antibiotic therapy with cephazolin was administered for all, and IV dexamethasone was prescribed to subside postoperative pain and edema.

All of the study variables were evaluated before orthognathic surgery and two months postoperatively. The amount of MMO (maximum mouth opening) and overjet were measured with a caliper. Clinical examination was done by an oral and maxillofacial surgeon to detect any TMJ sounds; this was accomplished without using a stethoscope. The duration of perioperative orthodontic treatment and the extracted teeth, due to orthodontic or other reasons, were also recorded.

Statistical analysis

Changes for opening before the operation and two months postoperatively were investigated using the Paired *t*-test. In order to determine whether TMJ sounds such as clicking and crepitus were associated with the type of performed surgery or not, Fischer's exact test was employed. Multiple linear regression analysis was used to assess the relationship between the dependent and independent variables. The dependent variables, as in the presence of unilateral or bilateral clicking, crepitus, or pain in the TMJ area, were evaluated postoperatively. The investigated independent variables assessed intra- or preoperatively are as follows: the patient's age, gender, overjet before orthognathic surgery, preoperative TMJ sounds or pain, duration of preoperative orthodontic treatment. The association between the mentioned factors and the amount of decrease in MMO after mandibular advancement surgery was analyzed with multiple linear regression. Whereas simple linear regression analysis was exclusively used just to determine to what extent preoperative MMO can influence postoperative MMO.

The remaining variables were assessed through Pearson Correlation Coefficient and Two Sample *t*-test. All data were subjected to statistical analysis

using SPSS version 20 (SPSS Inc, Chicago, IL) and $P=0.05$ was considered statistically significant.

RESULTS

Thirty patients including 15 men (50%) and 15 women (50%) with a mean age of (23.3 ± 2.7) yr and an age range of 18 to 27 yr were studied in terms of various variables in the following tables. Mandibular advancement was performed for all of the cases. In addition, maxillary setback and maxillary impaction surgeries were done for 6 (20%) and 4 (13.3%) cases, respectively. Moreover, the mean amounts of mandibular advancement displacement and maxillary setback and impaction were 3.30 ± 0.87 mm, 2.86 ± 0.74 mm, and 2.41 ± 0.57 respectively. The chi-square test showed no statistical difference in gender distribution between the different surgery groups ($P=.476$).

Table 1 shows the distribution of postoperative and preoperative TMJ Sounds based on the type of orthognathic surgery (Table 1). The distribution of the presence of preoperative TMJ symptoms was equal among the surgery groups, and no significant difference was found. The postoperative evaluation also demonstrated that there was no significant correlation between the presence of symptoms in the right or left TMJ and the type of surgery (Table 1).

After treatment was completed, the mean maximum mouth opening reduced from 39.03 ± 5.86 to 38.12 ± 6.05 , which was statistically significant ($P<0.001$).

Multiple linear regression analysis was used to assess the relationship between the preoperative contributing factors and the postoperative symptoms. Among the investigated variables, the only predictive factor was any sort of complaint regarding the TMJ area (such as pain or TMJ sounds), while the other factors did not have a statistically significant effect on the postoperative outcome (Table 2).

Pearson's correlation Coefficient helped analyze the relationship between the following factors, two by two: the amount of overjet, MMO before treatment, MMO after treatment, and the decrease in MMO after treatment. There was only a strong and significant relationship between the amount of MMO before and after treatment, while the remaining correlations were not statistically significant (Table 3).

Table 1: Distribution of Postoperative and Preoperative TMJ Sounds based on the Type of Surgery.

TMJ	Type of Surgery	N (%)	Preoperative					Postoperative					P value
			No sound	Click	Crepitus	Other sounds	Total	Type of Surgery	No sound	Click	Crepitus	Total	
Right side	Before Mandibular advancement	20 (66.6%)	15 (75%)	3 (15%)	2 (10%)	0 (0%)	20 (100%)	After Mandibular advancement	15 (75%)	3 (15%)	2 (10%)	20 (100%)	0.336
	Before Maxillary setback & mandibular advancement	6 (20%)	4 (66.7%)	2 (33.3%)	0 (0%)	0 (0%)	6 (100%)	After Maxillary setback & mandibular advancement	5 (83.3%)	1 (16.7%)	0 (0%)	6 (100%)	0.563
	Before maxillary impaction & mandibular advancement	4 (13.4%)	2 (50%)	1 (25%)	0 (0%)	1 (25%)	4 (100%)	After maxillary impaction & mandibular advancement	4 (100%)	0 (0%)	0 (0%)	4 (100%)	0.780
	Total	30 (100%)	21 (70%)	6 (20%)	2 (6.7%)	1 (3.3%)	30 (100%)	Total	24 (80%)	4 (13.3%)	2 (6.7%)	30 (100%)	0.333
	Before Mandibular advancement	20 (66.6%)	14 (70%)	3 (15%)	3 (15%)	0 (0%)	20 (100%)	After Mandibular advancement	16 (80%)	2 (10%)	2 (10%)	20 (100%)	0.360
Left side	Before Maxillary setback & mandibular advancement	6 (20%)	4 (66.7%)	2 (33.3%)	0 (0%)	0 (0%)	6 (100%)	After Maxillary setback & mandibular advancement	5 (83.3%)	1 (16.7%)	0 (0%)	6 (100%)	0.530
	Before maxillary impaction & mandibular advancement	4 (13.4%)	3 (75%)	0 (0%)	0 (0%)	1 (25%)	4 (100%)	After maxillary impaction & mandibular advancement	4 (100%)	0 (0%)	0 (0%)	4 (100%)	0.730
	Total	30 (100%)	21 (70%)	5 (16.7%)	3 (10%)	1 (3.3%)	30 (100%)	Total	25 (80%)	3 (13.3%)	2 (6.7%)	30 (100%)	0.365

Table 2: Multiple Linear Regression Analysis for Postoperative TMJ Symptoms. (Clicking, Crepitus or Pain in One or Both TMJs as the Independent variables).

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>P</i>	95,0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	.938	1.268		.740	.473	-1.801	3.678
Age	-.056	.029	-.481	-1.917	.077	-.119	.007
Sex	-.147	.327	-.163	-.449	.661	-.852	.559
surgery (mandible only/mandible & maxilla)	.065	.187	.069	.345	.736	-.340	.470
1 maximum opening before treatment	.019	.031	.235	.618	.548	-.048	.086
Overjet	-.054	.089	-.125	-.607	.554	-.246	.138
any complain/pain/sound before	.486	.187	.540	2.598	.022	.082	.890

Table 3: Pearson's Correlation Coefficient Between the patient's Overjet and Maximum Mouth Opening Parameters.

Variable	Overjet	Postoperative Maximum Mouth Opening	Preoperative Maximum Mouth Opening
Postoperative Maximum Mouth Opening	r=-0.103 P=0.232	----	-----
Preoperative Maximum Mouth Opening	r=-0.171 P=0.365	r=0.971 P<0.001	-----
Reduction in the amount of Maximum Mouth Opening	r=-.225 P=0.232	r=-0.254 P=0.161	r=-0.14 P=0.941

DISCUSSION

The current study has assessed how the TMJ responds to mandibular advancement, by analyzing specific factors such as an alteration in TMJ sounds, pain in the TMJ area and factors related to the orthognathic surgery procedures, as in the amount of mandibular advancement and whether isolated mandibular advancement was performed or simultaneous maxillary setback or maxillary impaction with mandibular advancement (bimaxillary surgery) was also performed. The demographic variables like the patient's age and gender were investigated as well. Although orthognathic surgery is generally not capable of completely changing the disk position and cannot correct anterior disk displacement, it seems like it can result in relief from arthralgia but, there is no individual guarantee upon this matter and is still relatively unpredictable^{3, 4, 19, 20}. The chances of bone resorption may drastically increase after mandibular advancement; this is especially evident in high-risk patients. The amount of mandibular advancement and counterclockwise rotation along with the type of employed surgical technique can highly contribute to the final condition of the TMJ tissues^{2, 12, 17, 18, 21}. In our study, the amount of mandibular advancement did not affect restricted mouth opening nor did it

affect the development of complaints regarding the TMJ area or TMJ sounds. This finding was in contrast to the overall inclination of some previously conducted studies, such as studies conducted by^{15-17, 21,22}. This may be rationalized by the fact that none of the studied cases required a extreme amount of mandibular advancement (more than 5 mm). In most of the present article cases, the amount of mandibular advancement was 5 mm or less. Whereas other studies^{14, 18}, also did not reveal a significant relationship between the mentioned factors, and was following the present study. Orthognathic surgery can cause a slight but statistically significant decrease for MMO, but it should be taken into consideration that patients were only evaluated until two months postoperatively; if we had a more extended follow-up period the obtained results could possibly be different. Experiencing pain and discomfort two months after mandibular advancement surgery is common and the TMJ tissues and muscle spasm may need a longer period to fully recover and regain their complete functional ability. The patient may also have been subconsciously nervous and cautious about opening one's mouth as much as possible only two months after undergoing mandibular advancement surgery, therefore the measured amount of MMO was less

than the real quantity. But either way to determine whether this restricted mouth opening is temporary or permanent, a longer follow-up period is necessary. The amount of maximum mouth opening after surgery only depended on the amount of preoperative MMO, and none of the other investigated factors were strongly predictive of the treatment outcome. Rigid fixation was accomplished through the positional screw technique proven to apply less force and tension to the fixed bones and condyle, compared to the lag screw technique. Only the superior part of the mandibular canal was fixed with screws, this can also result in a lower rigidity rate and decreased torque. Mini-screws cannot always provide appropriate and adequate rigidity and might eventually lead to some degree of relapse¹³.

None of the investigated patients suffered from severe pain or TMJ sounds and only presented mild discomfort in the TMJ area relieved after orthognathic surgery. The prevalence of clicking and crepitus was 20% and 7.6% for the right TMJ and 7.16% and 10% for the left TMJ, respectively, which reduced to a rate of 3.13% for clicking and 7.6% for crepitus after operation for both sides. As for TMJ noises that cannot be classified as either clicking or crepitus, one patient presented such sounds in the left TMJ and another patient presented such a sound in the right TMJ. This mentioned TMJ sound was completely gone after the operation.

Another variable was also analyzed, under the name of "any sort of pain/sound/complaint regarding the TMJ area". This was assessed based on any type of arthralgia, TMJ sounds, restricted mouth opening or spontaneous disk displacement, reported by the patient before and after operation. The recorded preoperative mean for each person was 0.32 ± 0.48 found to have a significant reduction after operation, resulting in a mean of 0.23 ± 0.43 .

These findings are in line with the majority of studies that also show a reduction in TMJ sounds after orthognathic surgery. However, there is no individual guarantee regarding this evolution and it is better not to be promised to the patient^{6,7,9,22}.

However, the literature presented methodological problems, which preclude making a definite conclusion. Supporting information to eliminate bias and strengthen the evidence is scarce. Recognized methodological problems included: sample size, indefinite and unclear inclusion criteria, the presence of heterogeneous groups consisting of patients who underwent different

types of surgery, lack of longitudinal observational and interventional studies, longitudinal studies with short follow-up periods, improper analysis methods, generalization of obtained results from in vitro studies to in vivo studies, limited research about the association between clinical findings and TMJ images, poor imaging techniques, problems that went unrecognized before surgery, different characteristics of patients regarding the skeletal relationship, race and age^{2, 3, 14-18}.

All the mentioned factors can contribute to obtaining unreliable results. The purpose of a two-month follow-up period was to evaluate the pure influence of surgery on TMJ dysfunction. Thereafter orthodontic treatment was continued for patients and a longer follow-up period would assess the combined effect of surgery and orthodontic treatment on TMJ dysfunction.

Limitations

The present article highlights the effect of orthognathic surgery on TMJ symptoms. Since this study was carried out through a small population, it would be best if similar studies with a multicenter population were conducted across the country. Future studies would work best if patients were followed for a longer period in addition to once again evaluating the investigated factors after orthodontic treatment has been completed for the patient. This would explore how a comprehensive orthodontic-surgery therapy can influence TMJ dysfunction. Moreover, due to the COVID-19 pandemic in the world and Iran and quarantine protocols, it was not possible to follow up the patients for a longer period.

CONCLUSION

In short-term after the mandibular advancement orthognathic operation, the rate of pain, sounds or any type of complaint regarding the TMJ area was relatively low and less in comparison to the preoperative state. Only preoperative pain or noises or complaints were predictive factors for postoperative TMJ dysfunction ($P=0.022$). None of the other investigated factors such as the amount of mandibular advancement, the type of performed surgery (isolated mandibular advancement or bimaxillary surgery), the patient's age and gender, the duration of pre-surgery orthodontic treatment and the extracted teeth; were identified as predictive

variables for postoperative TMJ dysfunction. In other words, if a patient presenting TMJ dysfunction undergoes mandibular advancement, these symptoms may reduce and there is a strong chance of observing less intense postoperative symptoms. More clinical trials with greater sample sizes and long-term follow-ups are suggested in the future.

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CONFLICTS OF INTEREST

None declared.

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