Journal of Craniomaxillofacial Research

Vol. 9, No. 1 Winter 2022

Evaluation of the temporomandibular disorders after orthognathic surgeries: A review

Mina Khayamzadeh [1], Farnoosh Razmara [2*], Majid Salehi Karizmeh [1]

1. Department of Orol and Maxillofacial Medicine, School of Dentistry, Tehran University of Medical Sciences, International Campus, Tehran, Iran.

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

ARTICLE INFO

Article Type:
Review Article

Received: 8 Apr. 2021
Revised: 5 Jun. 2021
Accepted: 19 Sep. 2021

**Corresponding author:*
Farnoosh Razmara

Craniomaxillofacial Research Center, Tehran University of Medical Sciences, Tehran, Iran; Department of Oral and Maxillofacial Surgery, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

Tel: +98-21-84902473
Fax: +98-21-84902473
Email: farnooshrazmara@Gmail.com

ABSTRACT

Objective: Maxillofacial Orthognathic surgery is performed to repair or correct the skeletal anomalies of the jaw and its associated dental and facial structures. There is a conflict on whether orthognathic surgery has a negative or positive effect on temporomandibular disorders (TMD). The aim of this study is to review the disorders of the temporomandibular joint after orthognathic surgery.

Materials and Methods: Data for this review was obtained from the articles published between 2010-2020 via PubMed, Google scholar, Web of Sciences, and Scopus engines. The content keywords matched those used in PubMed and Mesh engines. Based on the inclusion and exclusion criteria; 27 articles were included.

Results: Most of the selected articles were retrospective reviews and performed on class II and class III patients. Ages ranged from 19- 47 years. Pain reduction was reported in 11 studies, while 8 studies reported a click reduction post orthognathic operation. In 2 studies, decreased joint noises was reported after orthognathic operation, and 7 articles reported a decrease in maximum mouth opening. Three studies reported a Bilateral Sagittal split Osteotomy (BSSO) and in one study, reduced and improved symptoms after Le Fort I + (BSSO) were reported. One study exhibited that BSSO orthognathic surgery is less predictable in reducing TMD symptoms in retrognathic patients. Three articles showed that orthognathic patients with TMJ click have a high predictive value.

Conclusion: To accomplish accurate results regarding temporomandibular joint disorders post orthognathic surgery; a larger number of subjects and clinical trial studies are required, as well as extended long term follow-up.

Keywords: Temporomandibular joint; Mandibular advancement; Mandibular setback; Maxillary impaction; Maxillary advancement.

Introduction

Orthognathic surgery is a surgical intervention that corrects or changes the relationship between the jaw and face which has an affect on the TMJ and oral function [1]. A combination of genetic and environmental variables can induce dental arch asymmetry, which can cause skeletal, dental, and functional sequela [2]. Some studies have reported a higher prevalence of dental arch asymmetry in people with Class II or Class III malocclusion than normal occlusion [3][4]. The short face syndrome is caused by one of four deviations: vertically

deficient anterior height of the mandible, retropositioned mandible with accentuated vertical overbite, maxillary retropositioning with mandibular overclosure, or maxillary vertical deficiency and short middle third of the face [5]. Long face syndrome is caused by excessive vertical craniofacial growth [6]. Maxillary push Back surgery, Maxillary advancement, Mandibular setback, Mandibular advancement and also Maxillomandibular/Bi-Maxillary surgery and Maxillary impaction surgery are the most common orthognathic surgeries [7]. OS is indicated to improve function, decrease the duration of treatment, achieve stability following orthodontic treatment, and to prevent relapse [8][1].

The orthognathic procedure is regarded as a low-risk and successful procedure in dentistry. Oral function success can be measured in a variety of ways, including the presence or absence of joint noises, mandibular motions, maximal mouth opening, pain on palpation, bite force, and patient satisfaction [1]. Temporomandibular disorders (TMD) are amongst the foremost prevailing disorders in the maxillofacial region that may affect the masticatory muscles and temporomandibular joint. Symptoms of this disorder include pain, jaw dysfunction, malocclusion, jaw deviation while opening or closing the mouth, limited movement, sound and joint locking, headache, and sleep disturbances [9]. According to epidemiological studies, 75% of the adult population have at least 1 sign of TMD upon examination [10]. However, only 5% of the TMDs patients need a definitive treatment, while a less percentage may develop chronic symptoms [11]. Generally, most symptoms can be relieved by using simple self-care therapies, such as chewing soft food. However, for patients who have not experienced relief from self-care therapies, various noninvasive therapies up to a variety of surgeries can be undertaken [12]. Laser acupuncture has been found to be a safer alternative in the reduction of pain in patients with TMD [9]. There is a conflict as to whether or not orthognathic surgery has a negative or positive impact on temporomandibular disorders (TMD). Some researchers trust that orthognathic surgery has a positive effect on pre-existing TMD [13] [14]. some found it ineffective [15] and some have reported that orthognathic surgery can cause TMD or may worsen the condition by affecting the joint, masticatory muscle and surrounding soft tissues [16]. A systematic review by Veldhuis et al found that orthognathic surgeries seem to have little or no harmful effect on the TMJ and oral function. They stated that this conclusion is very difficult due to the variety of surgical techniques, examination techniques, diagnostic criteria in addition to imaging techniques and the quality of study design, and further studies are recommended to clarify the dimensions of this issue [1]. In a meta-analysis study conducted by Al-Moraissi et al; it was reported that although orthognathic surgery relieved discomfort in symptomatic patients, it caused symptoms in a small group of previously asymptotic patients [17]. Due to the restricted available information about TMDs, especially after various orthognathic surgeries, the aim of this study is to review the disorders of the temporomandibular joint after orthognathic surgery.

Material and Methods

Data for this study was selected from studies conducted between January 2010 and September 2020 via four major databases; Web of Science, PubMed, Scopus and Google Scholar. The combined keyword "temporomandibular joint" was searched separately, as well as the following: Arthralgia OR disc displacement OR joint clicking OR myofascial pain OR deviation on mouth opening OR headache OR joint crepitation OR muscle tenderness OR TMJ pain OR signs OR symptoms OR TMD OR joint sound OR unreducible disc OR stomatognathic OR temporomandibular joint disorder OR temporomandibular joint disorder dysfunction. These terms were also searched in combination with the orthognathic surgery subgroup keywords, including: Orthognathic surgery OR bilateral sagittal split osteotomy OR BSSO OR intraoral vertical ramus osteotomy OR IVRO OR Le Fort I OR bimaxillary surgery OR setback OR advancement OR single jaw surgery OR double jaw surgery.

For studies to meet the inclusion criteria, they had to describe the TMDs post orthognathic treatment of patients and had to be published in English, exclusion criteria included review studies, low quality studies in the hierarchy of scientific evidence (such as doctoral dissertations, expert opinions, letters, editorials, histological studies), animal studies, case reports, technical reports, laboratory studies of patients with systemic conditions, studies that did not report outcomes (before and after surgery) and studies published before 2010. Only 27 articles were selected. The following variables were extracted: citation (author/year), title, type of study, patients' number, presence or absence of a control group, clinical examinations (rate of mandibular movement, maximum mouth opening and pain on palpation), using the Helkimo index [18], Using the Research Diagnostic Criteria for TMDs (RDC/TMDs)

[19], the country under study, and the results of the patient questionnaire.

Result

The electronic computer search yielded a total of 936 potentially relevant articles using the previously mentioned predefined keywords, only 27 articles appeared to meet the above-mentioned criteria (figure 1). An overview of all included studies is given in (Table 1). As shown in (Table 2), most of the selected articles were retrospective reviews and performed on class II and class III patients. Ages ranged from 19-47 years. The follow-up intervals were 1 month to 3 years. (Table 3) shows that only 8 studies used the Helkimo index and 9 studies used the RDC/TMDs index. While evaluating studies based on the type of performed surgery: 9 studies reported BSSO and Le Fort I [20-28] 9 studies reported BSSO [16][21-25][28-30], 3 studies reported Le Fort I+BSSRO [31-33], 4 studies reported Le Fort I [16][23][34][33], 2 studies reported BSSRO [34][31], 1 study reported BSSR [33], 1 study reported Le Fort I osteotomy & SSRO [34], 1 study reported Mandibular setback surgery [35], 1 study reported mandibular Or maxillary osteotomy [36], 1 study reported bilateral vertical ramus osteotomy with or without maxillary osteotomy [37].

Three studies mentioned that orthognathic surgery caused a small group of asymptomatic patients to develop symptoms post surgery [20][22][27]. Twelve studies reported that symptoms could be relieved after orthognathic surgery [20][22-27][31-33][36][37]. Decreased pain after orthognathic surgery was reported in 11 studies [21][22][25-28][30][31][33][36][37]. Eight studies reported decreased click post orthognathic operation [21][24][26-28][30][33][36]. In 2 studies, decreased joint noises was reported after orthognathic operation [22][32]. A decrease in maximum mouth opening post orthognathic operation was reported in 7 articles [24][27][28][30][33][36][37]. In one study, reduced and improved symptoms after Le Fort I+(BSSO) was reported [22]. Three studies reported TMJ problems post BSSO [22][29][30]. One study reported that orthognathic surgery reduces parafunctional habits [23], and another assumed that there is no significant effect of the type of the surgery on the TMDs changes postoperatively [31]. In 1 study, the lack of fine effect of Le Fort I surgery on TMD postoperatively was reported [16]. The mandibular setback surgery or maxillary advancement surgery has no significant effect on TMDs symptoms, as reported by one study [28], while other studies showed that patients undergoing bimaxillary osteotomy procedures were more at risk for developing TMDs [23][16]. One study showed that in patients with retrognathia, BSSO orthognathic surgery was less predictable in alleviating TMD symptoms [29]. Another study reported that Le Fort I + BSSO orthognathic surgery may not reduce the symptoms of TMD [26]. Three studies showed that orthognathic patients with TMJ click have a high predictable value [16][32][27]. One study reported that temporomandibular disorders after orthognathic surgery were associated with a pre-operative history of parafunctional or dysfunctional oral habits [38]. Another study reported that parafunctional habits have no significant effect on postoperative TMD [16]. According to one study, preoperative TMD symptoms may have a greater influence on postoperative TMD symptoms than mandibular setback utilizing SSRO with rigid fixation [34] (Table 4).

Figure 1. Data extraction flowchart.

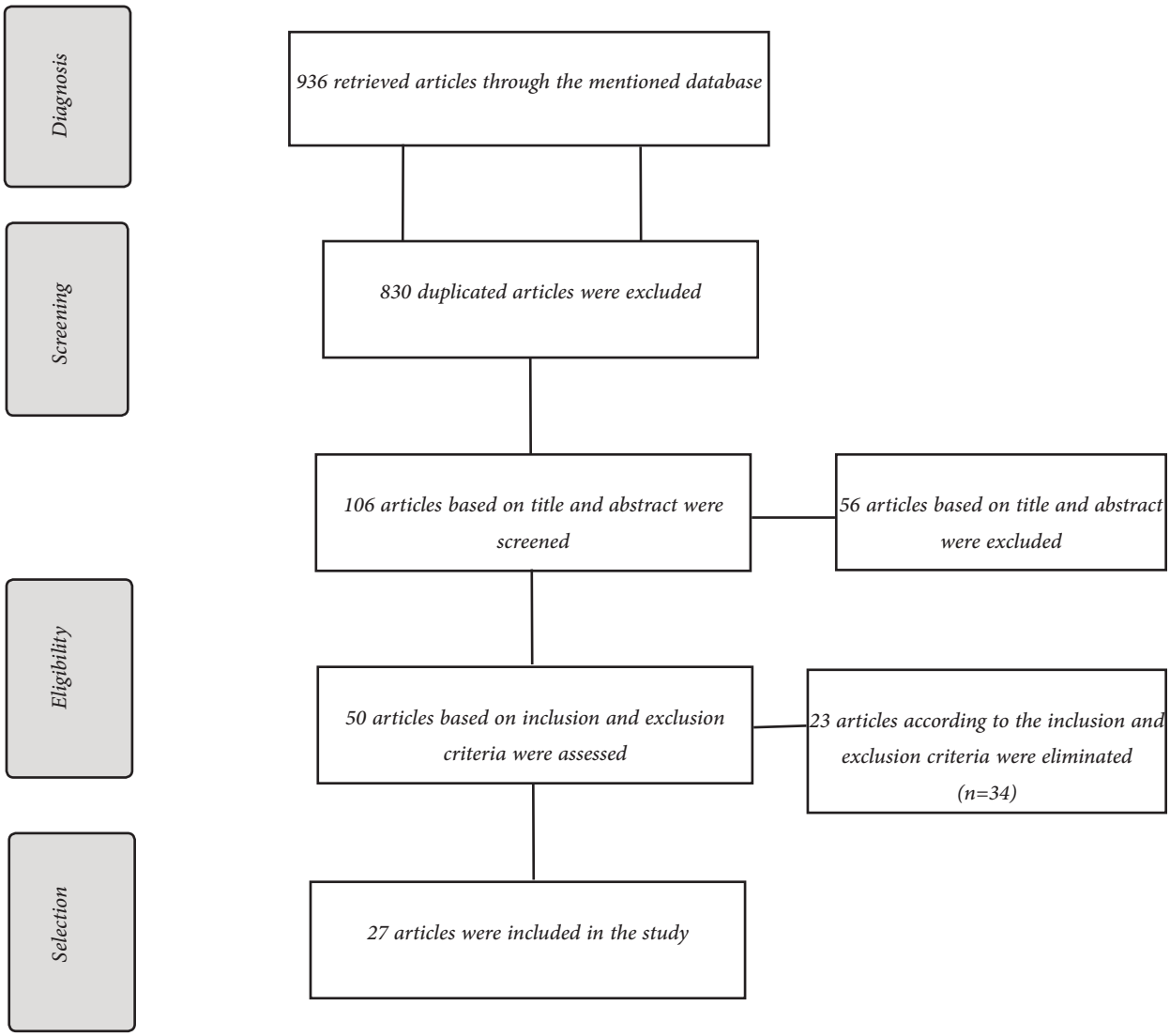

Table 1. Specification of review articles.

1	*Hasani Mehraban et al [44] 2020, Iran.* *Title: Evaluating the Effectiveness of Orthognathic Surgery on the Pre-existing Temporomandibular Disorders in Patients with Malocclusion.* *Study Duration: 2001-2019.* *Inclusion criteria: The RCT, prospective and retrospective cohort studies, and controlled clinical trials; Studies conducted on humans; Patient undergoing orthognathic surgery with/without pre-existing TMDs.* *Results: Five studies (prospective) have been included in the review, the Follow-up period ranged from 1 week to 24 months, no significant correlation between TMD and occlusal condition, patients with the corrected malocclusion by orthognathic or orthodontics surgeries had a considerable rate of incidence of TMD in comparison with the controls.*
2	*Al-Moraissi et al [17] 2017, United State* *Title: Does Orthognathic Surgery Cause or Cure Temporomandibular Disorders?.* *Study Duration: 1980-2016.* *Inclusion criteria: patients with Class II and III skeletal and occlusal relationships or other dentofacial deformities indicated for orthognathic surgery, clinical human studies, RCT, controlled clinical trials, retrospective studies, and case series with the aim of comparing preexisting preoperative TMDs with postoperative TMDs after orthognathic surgery treatment.* *Results: There was a significant reduction in TMDs in patients with a retrognathic mandible after bilateral sagittal split osteotomy (BSSO) (P=.014), but no significant difference after bimaxillary surgery (BSSO and Le Fort I osteotomy) (P=.336). Orthognathic surgery caused a decrease in TMD symptoms for many patients who had symptoms before surgery, but it created symptoms in a smaller group of patients who were asymptomatic before surgery.*
3	*Te Veldhuis et al [1] 2017, Netherlands.* *Title: The effect of orthognathic surgery on the temporomandibular joint and oral function.* *Study Duration: Until 2015.* *Inclusion criteria: Articles included treatment of humans and had to be published in English.* *Results: 76 relevant articles were included, the great variety of orthognathic surgery techniques, examination techniques, diagnostic criteria, and imaging techniques used in the articles studied, as well as the quality of the study designs, made it difficult to compare studies and to draw conclusions, However, looking at the different aspects studied in general, it can be stated that orthognathic surgery seems to have little or no harmful effect on the TMJ and oral function.*
4	*Jedrzejewski et al [45] 2015, Poland* *Title: Preoperative, intraoperative, and postoperative complications in orthognathic surgery.* *Study Duration: Until 2015.* *Inclusion criteria: No publication date restrictions were imposed. All systematic reviews, randomized controlled trials, clinical trials were considered. English, German, French, or Polish language articles were included in the search. Patients of any age who had any orthognathic surgery procedure were evaluated in this review.* *Results: An evaluation of the obtained studies revealed the existence of a large number of varied complications associated with orthognathic surgery procedures.*
5	*Bermell-Baviera et al [46] 2016, Spain.* *Title: Effects of mandibular advancement surgery on the temporomandibular joint and muscular and articular adaptive changes* *Study Duration: 2002-2014.* *Inclusion criteria: Human studies, Angle Class II, RCT, cohort studies and case–control studies, both prospective and retrospective.* *Results: 22 articles were reviewed. Mandibular advancement surgery with condyle repositioning is associated with less TMD. Despite the large number of studies on the effects of mandibular advancement surgery on the temporomandibular joint (TMJ), this surgery can neither be said to improve nor to worsen TMJ health.*
6	*Lindenmeyer et al [47] 2017, United Kingdom.* *Title: Oral and Maxillofacial Surgery and Chronic Painful Temporomandibular Disorders.* *Study Duration: Until 2009.* *Inclusion criteria: Studies with the primary aim to investigate the relation between TMD and oral surgery procedures, especially the removal of impacted third molars, orthognathic surgery, or implant insertion.* *Results: Oral surgical trauma or gross malocclusion has a causative role in the onset of TMD. However, there was no overall evidence of a surgical causal etiology or orthognathic.*

Table 2. Characteristics of included studies.

Authors, Year of Publicatio	Study Design	No. of Patients	Male-Female Ratio	Patient Age (Average), yr.	Dento facial deformities	How Outcomes Were Measured	Follow-Up Period (Year)
Dujoncquoy et al [20] 2010 Germany	Retrospective	57	22:35	21/31	NM	Questionnaire	2.5
Silva et al [36], 2011 Swede	Retrospective	20	3:17	25/5	Class II: 11 Class III: 9	Clinical examination	1 mo.
Ramieri et al [21], 2011 Italy	Prospective	11	6:5	23/1	class III	Clinical examination	2 yr.
Abrahamsson et al [37], 2013 Sweden	Prospective	98	51:70	NM	Class II: 27 Class III: 58	Clinical examination using RDC/TMD	3
Togashi et al [22] 2013 Japan	Prospective	170	37:133	21	170	Clinical examination	1
Kim et al [31], 2013 Korea	Preliminary study	22	13:9	22/5	Mandibular prognathism	Clinical examination	6 mo.
MladenoviĆ et al [48], 2013 Serbia	Case control	40	15:25	22/8	Mandibular prognathism	Clinical examination, Questionnaire	9-13 mo.
Scolozzi et al [23] 2015 Switzerland	Retrospective	219	96:123	24/9	Class I: 4 Class II: 76 Class II: 88 Open bite: 42 Others: 13	Clinical examination, dysfunction index	1
Yoon et al [32], 2015 Korea	Prospective	54	18:36	24/4	Class III	Clinical examination, Self-reporting, Questionnaire	6 mo.
Christovam et al [33], 2016 Brazil	Retrospective	15	12:3	19-47	Class III	Clinical examination, Questionnaire	6 mo.
Kuhlefelt et al [29] 2016 Finland	Prospective	40	41:26	36/9	Class III	Clinical examination, dysfunction index	1
Sebastiani et al [24], 2016 Brazil	Cohort	54	17:37	29	Class I: 4 Class II: 17 Class II: 33	Clinical examination, Questionnaire	6 mo.
Takahara et al [34], 2017 Japan	Prospective	24	10:14	23/7	Mandibular prognathism: 7 mandibular prognathism with maxillary deformity: 17	Clinical examination	6 mo.
Di Paolo et al [25], 2017 Italy	Retrospective	76	2:3	27	NM	Questionnaire	6 mo.-1 yr.

Antonarakis et al [16], 2017 Switzerland	Cohort, Retrospective	88	39:49	24/5	Class III	Clinical examination, Questionnaire	1 yr.
Hashemi et al [30], 2018 Iran	Prospective	81	26:55	19:31	Cl II	Clinical examination, Questionnaire	6 mo.
AlWarawreh et al [26], 2018 Jordan	Retrospective	100	13:69	27-7	Cl II: 47 Cl III: 53	Clinical examination, Questionnaire	1 yr.
Kretschmer et al [27], 2019 Germany	Retrospective	500	173:327	28	NM	Clinical examination, Questionnaire	1 yr.
Sefidroodi et al [23], 2019 Norway	Retrospective	36	12:34	34/1	Genuine mandibular prognathism	Questionnaire	10-15yr
Bruguiere et al [38], 2019 France	Cohort, Prospective	237	NM	25/3	Cl I: 1 Cl II: 148 Cl III: 63	Clinical examination	1 yr.
Ploder et al [28], 2020 Austria	Cohort, Retrospective	375	128:248	28/1	Cl &II: 269 Cl III: 106	Clinical examination	2 yr.

Table 3. Investigation of studies based on the use of Helkimo indices, RDC/TMDs and radiographic image.

Authors, Year of Publication	Using Helkimo index	Using RDC/TMDs index	Type of radiographic images
1. Dujoncquoy et al, 2010 [20]	NO	NO	NO
2. Silva et al, 2011 [36]	NO	NO	NO
3. Ramieri et al, 2011 [21]	NO	YES	MRI
4. Abrahamsson et al, 2013 [37]	NO	YES	NO
5. Togashi et al, 2013 [22]	NO	NO	CT
6. Kim et al, 2013 [31]	NO	YES	Radiology
7. Mladenović et al, 2013 [48]	NO	YES	NO
8. Scolozzi et al, 2015 [23]	YES, no significant difference seen in pre and post operation	YES	NO
9. Yoon et al, 2015 [32]	YES	YES	CBCT
10. Christovam et al, 2016 [33]	YES	NO	NO
11. Kuhlefelt et al, 2016 [29]	YES, Reduced	NO	NO
12. Sebastiani et al, 2016 [24]	NO	YES	NO
13. Takahara et al, 2017 [34]	NO	NO	MRI
14. Di Paolo et al, 2017 [25]	YES	YES	NO
15. Antonarakis et al, 2017 [16]	YES, no significant difference seen	YES	NO
16. Hashemi et al, 2018 [30]	NO	NO	Cephalometric
17. AlWarawreh et al, 2018 [26]	NO	NO	MRI, CT, Panoramic
18. Kretschmer et al, 2019 [27]	NO	NO	Panoramic
19. Sefidroodi et al, 2019 [35]	YES, index ٤	NO	NO
20. Bruguiere et al, 2019 [38]	NO	YES	NO
21. Ploder et al, 2020 [28]	YES	NO	NO

Table 4.

	Studies and Results
1	Author, year of publication: Dujoncquoy et al, 2010 [20]. Type of orthognathic surgery: BSSO and Le Fort I. Evaluated variables: pain, sounds, clicking, joint locking, limited mouth opening, and tenseness. Results: • Pre-Surgery: Pain:28.1%, sound: 38.6%, tenderness: 12.3%, click:33.3%, joint locking: 19.3%, limited mouth opening: 15.8% was reported. • Post-surgery improvement values: Pain 43.8%, sound: 72.2%, tenderness: 27.3%, click: 73.7%, joint locking: 27.3%, and limited mouth opening: 22.2%. • 80% of patients reported improvement, 16.4% unchanged, and 3.6% worsened. Conclusion: These observations demonstrate that: there is a high prevalence of TMJ disorders in dysgnathic patients; most of patients with preoperative TMJ signs and symptoms can improve TMJ dysfunction and pain levels can be reduced by orthognathic treatment; a percentage of dysgnathic patients who were preoperatively asymptomatic can develop TMJ disorders after surgery but this risk is low.
2	Author, year of publication: Silva et al, 2011 [36]. Type of orthognathic surgery: Orthognathic and orthodontic treatment, Mandibular/Maxillary ostectomy. Evaluated Variables: Headache; pain in facial muscles and/or in TMJ; pain during chewing; auditory or vestibular aspects and jaw movements. Results: • All symptoms (Pain during chewing, pain in facial muscles and/or in TMJ, headache, mandibular movement) decreased after surgery. • Reduction in maximum mouth opening. Conclusion: The orthodontic-surgical treatment resulted in short term decrease of the investigated symptoms and clinical signs of pain in cervical muscles, and reduction of mandibular opening in patients with dentofacial deformities.
3	Author, year of publication: Ramieri et al, 2011 [21]. Type of orthognathic surgery: BSSO (n=6), BSSO+Le Fort I (n=5). Evaluated Variables: Myofascial pain, joint clicking, MRI findings, computerized axiography. Results: • Myofascial pain: Pre-surgery 1 patient, post-surgery 0 patient. • Joint Clicking: pre-surgery 7 patients, post-surgery 3 patients. • According to MRI: Before surgery normal disk position in 91%, disk displacement with reduction 4.5%, and DDNR 4.5%. These findings were unchanged after surgery. • Computerized axiography: Significant increase in both protrusive tracing with normal length from 41% to 76%, and in tracing with normal morphology in sagittal plane from 50% to 83%, significant drop in tracing with deviation from 23% to 7%. Conclusion: Mandibular setback surgery does not appear to alter the condyle disk relationship, whereas correction of class III malocclusion seems to improve clinical and CA signs of TMJ function. Further controls and more long-term evaluation of these patients are necessary to assess the maintenance of these improvements in time.
4	Author, year of publication: Abrahamsson et al, 2013 [37]. Type of orthognathic surgery: Bilateral vertical ramus osteotomy with or without maxillary osteotomy. Evaluated Variables: Myofascial pain, disc displacement and arthralgia, TMD symptoms includes: pain at rest, chewing, during mouth opening, or all three together. Weekly: Pain, Jaw tiredness and TMJ clicks and maximum mouth opening. Results: • Reduction in myofascial pain, disc displacement and arthralgia post treatment. • Reduction in all evaluated TMD symptoms. • Reduction in maximum mouth opening from mm 8±50to mm 7±48. Conclusion: Patients with dentofacial deformities, corrected by orthodontic treatment in conjunction with orthognathic surgery, seem to have a positive treatment outcome in respect of TMD pain. The frequency of TMD was comparable in the two groups.

5	*Author, year of publication:* Togashi et al, 2013 [22]. *Type of orthognathic surgery:* Le Fort I + BSSO (N=112), BSSO (N=580). *Evaluated Variables:* Pain, sounds and limitation in mandibular range of motion. *Results:* Pre-surgery: pain 4.1%, joints sound 21.8%, limited mouth opening 0.5, more than one symptom 24.1% One year post surgery: pain 1.8%, joints sound 10.6%, limited mouth opening 0% and several symptoms together 11.8% Changes of sign and symptoms one year post OP in comparison to one year before surgery: • From asymptomatic to asymptomatic (unchanged): 59.4% to 64.7%. • From asymptomatic to symptomatic: 11.8% with 6.5%. • From symptomatic to asymptomatic: 11.2% to 23.5%. • From symptomatic to symptomatic (unchanged): 17.6% to 3.5% Changes of sign and symptoms one year post OP in comparison to one year before surgery in accordance to the type of surgery performed: Le Fort I + BSSO surgery (N = 112) • From asymptomatic to asymptomatic (unchanged): 58% to 62.5% • From asymptomatic to symptomatic: 11.6% to 7.1% • From symptomatic to asymptomatic: 9.8% to 25% • From symptomatic to symptomatic (unchanged): 20.5% to 4.5% BSSO surgery (N=58). • From asymptomatic to asymptomatic (unchanged): 62.1% to 69%. • From asymptomatic to symptomatic: 12.1% to 2.5%. • From symptomatic to asymptomatic: 13.8% to 20.7% • From symptomatic to symptomatic (unchanged): 1.12% to 2.5%. *Conclusion:* Surgical orthodontic treatment has a beneficial effect on TMJ signs and symptoms in most patients with dentofacial deformities. However, there is a risk of TMJ symptoms and signs developing in preoperative asymptomatic patients after orthognathic surgery though the risk is low.
6	*Author, year of publication:* Kim et al, 2013 [31]. *Type of orthognathic surgery:* BSSRO (10=n), Le Fort I+BSSRO (12=n). *Evaluated variables:* TMD and pain scale *Results:* • Patients without TMD prior to orthognathic surgery did not develop noticeable TMD symptoms even 6 months after surgery. Among the 12 patients with TMD, 2 out of the 7 patients with internal derangement of the TMJ were diagnosed as normal after surgery, and 1 patient with myofascial pain dysfunction syndrome was determined to be without symptoms after surgery • Prior to surgery, 75.0% of patients were low disability patients (Grade 0-II pain), whereas 25.0% of patients were high disability patients (Grade III-IV pain). All of the patients became low disability patients after surgery ($p<0.05$, Table 6). However, the changes from before surgery to after surgery were not statistically significant for the surgery type and gender subgroups. *Conclusion:* The RDC/TMD Axis II was developed to diagnose TMD, but we believe the RDC/TMD Axis II can help to establish postoperative treatment plans by evaluating a patient's psychological and psychosocial state.

7	*Author, year of publication:* Mladenović et al, 2013 [48]. *Type of orthognathic surgery:* Rigid fixation (RF) with miniplates (20=n), Rigid fixation (RF) with wires (20=n). *Evaluated Variables:* Myofascial pain, disc displacement, TMD symptoms, pain, deviation on opening or closing of the mandible, restricted opening of the mandible, pain on movement of the mandible, muscle pain on palpation, TMJ pain on palpation *Results:* • Incidence of TMD: In the orthognathic surgery group with TMD: 47.5% without TMD: 52.5%, in the control group (without treatment) with TMD: 57.1% without TMD: 42.9%. • Myofascial pain: in orthognathic surgery group: 90.5% control group: 50%. • Disk displacement: in orthognathic surgery group: 38.1% control group: 66.7%. • Arthralgia, arthritis, arthrosis: In orthognathic surgery group: 0% Control group: 27.8%. • Presence of 1 or more TMD symptoms: in orthognathic surgery group: 100% control group: 87.8%. • Pain: in orthognathic surgery group: 5% control group: 9.5%. • Deviation on opening or closing the mandible: in orthognathic surgery group: 55% control group: 57.1%. • Restricted opening of the mandible: in orthognathic surgery group: 15% control group: 1/7%. • Pain on movement of the mandible: in orthognathic surgery group: 30% control group: 23.8%. • Muscle pain on palpation: in orthognathic surgery group: 45% control group: 31%. • TMJ pain on palpation: in orthognathic surgery group: 25% control group: 11.9%. *Conclusion:* Prevalence of TMD immediately after completion of orthodontic-surgical treatment for mandibular prognathism is similar to frequency of dysfunction in untreated subjects, is significantly higher in females and is most commonly myogenic. Furthermore, females show an increased level of chronic pain post-operatively. Somatization and depression levels do not differ between patients with corrected prognathism and untreated prognathic patients.
8	*Author, year of publication:* Scolozzi et al, 2015 [23]. *Type of orthognathic surgery:* Le Fort I (n=44), BSSO (n=51), Le Fort I+BSSO (n=124). *Evaluated variables:* TMJ and masticatory muscle examination to assess the following symptoms and signs: pain in the TMJ; pain in the masticatory muscles; pain on mandibular movements; hearing sounds from TMJ joints; feeling fatigue, stiffness upon awakening and on mandibular movements, or both; difficulty opening the mouth wide or yawning; TMJ locking, luxation, or both; and parafunctional habits (bruxism or clenching). Clinical examination that included (a) intraoral examination: Angle classification of malocclusion, overjet, overbite, maximal interincisal opening, maximal lateral and protrusive movements, deviation and pain at the mouth opening and palpation of the masticatory muscles; and (b) extraoral examination: TMJ palpation to determine the presence of pain at rest and at opening of the mouth, as well as the presence and the type of articular sounds (clicking or crepitus) and palpation of the masticatory muscles to determine the presence of pain *Results:* • The global prevalence of TMDs slightly decreased after surgery, and although not statistically significant. • Parafunctional habits decreased from 27.4% to 16.9% with p=0.003 • TMJ luxation decreased from 2.7% to 0% with p=0.03 • Deviation at the mouth opening increased from 15.5% to 18.7% with p=0.04 • Maximal interincisal opening increased from 7.2% to 7.8% with p=0.0005 • Maximal mandibular protrusion decreased from 3% to 2.3% with p=0.0001 • Painful masticatory muscle palpation was significantly associated with a higher Di (on average, +0.31 more Di points on average when the sign was present and P=.004). • Other variables showed no significant differences. *Conclusion:* This study demonstrated that in orthognathic patients, the following factors had high predictive value: (1) anamnestic TMJ clicking for TMD, (2) TMJ clicking, TMJ pain on palpation and bimaxillary surgery for Ai worsening, (3) maxillary retrusion and mandibular excess for Ai improvement, and (4) pain on masticatory muscle palpation for Di worsening.

9	*Author, year of publication:* Yoon et al, 2015 [32]. *Type of orthognathic surgery:* Le Fort I+ BSSRO. *Two groups:* patients that had no preoperative TMD treatments (sex: 4 males and 11 females, mean age: 24.8 ± 2.76 years, range: 21 - 31 years). Control group that had been treated until the symptoms and signs of TMD alleviated (consisted of 15 patients; sex: 7 males and 8 females, mean age: 24.4 ± 4.29 years, range: 18-31 years). *Evaluated Variables:* (1) TMJ pain during function (mouth opening or mastication), (2) TMJ noise on jaw movement, (3) LOM under 35mm. The study group were examined in three times: before the preceding treatments for TMD, before surgery and 6 months after surgery. The control group were examined in two times: before surgery and 6 months after surgery. Self-reported questionnaire consisted of several questions regarding the subjective changes of TMJ symptoms. *Result:* The study group: Pain: TMJ before study (0) and after study (0) (P=0.03), TMJ noise: before study (66.7%) and after study (40%) (P=0.001), LOM: before study (0) and after study (0) (P=0.03), asymptomatic: before study (0%) and after study (46.7%). TMJ pain improved in 20%, worsened in 0%, and remained unchanged in 80%. TMJ noise improved in 63.5%, deteriorated in 0% and remained unchanged in 36.5%, LOM improved in 0%, worsened in 0% and remained unchanged in 100%. The control group: Pain: TMJ before study (20%) and after study (20%) (P=0.183), TMJ noise: before study (26.7%) and after study (13.3%) (0.000)=P), LOM: before study (0) and after study (0) (P=0.03), asymptomatic: before study (0%) and after study (33.3%). TMJ pain improved in 40%, worsened in 13%, and remained unchanged in 47%. TMJ noise improved in 56.5%, worsened in 3.5% and remained unchanged in 40%, LOM improved in 13%, worsened in 0% and remained unchanged in 87%. *Conclusion:* 2 jaw surgery without preceding treatments for TMD can have therapeutic effect for TMD patients with class III malocclusion.
10	*Author, year of publication:* Christovam et al, 2016 [33]. *Type of orthognathic surgery:* BSSR, Le Fort I and BSSR+Le Fort I. *Evaluated variables:* Pain on palpation of masticatory muscles, click, crepitation, mouth opening *Result:* • Significant reduction of painful sensitivity of the masticatory muscles (medial pterygoid and lateral pterygoid) after surgery. • Comparison with pre-surgery: reduction of mouth opening, significant reduction of clicks, significant reduction of facial pain, no significant difference in crepitation. *Conclusion:* Improvement of TMD after orthognathic surgery may not be the result of correcting malocclusion and satisfaction with the results can be a factor of TMD improvement.
11	*Author, year of publication:* Kuhlefelt et al, 2016 [29]. *Type of orthognathic surgery:* BSSO. *Evaluated Variables:* Anamnestic index and Dysfunction index. *Result:* • 42.5% had preoperative TMD symptoms. • Post operation: (25%) had improved Ai scores, and 30% had improved Di scores. *Conclusion:* Surgery for orthognathia is a predictable treatment for improving aesthetics and occlusion but less predictable for alleviating TMD symptoms in patients with retrognathia. TMD symptoms should therefore be treated independently.
12	*Author, year of publication:* Sebastiani et al, 2016 [24]. *Type of orthognathic surgery:* Le Fort I, BBSSO or both. *Evaluated Variables:* Click, muscular disorders, arthralgia, TMJ sounds, and mouth opening with/without pain. *Result:* • Reduce Muscular Disorder, Arthralgia and Click. • Reduction of maximum mouth opening with/without pain after surgery (Generally pre-operative maximum mouth opening without pain improved to 6 months after surgery). • Significant reduction in the incidence of TMD after orthognathic surgery (P<0.001). • Significant reduction in postoperative TMD severity. *Conclusion:* Orthognathic surgery reduces the clinical signs and symptoms of TMD.

13	*Author, year of publication:* Takahara et al, 2017 [34]. *Type of orthognathic surgery:* Bilateral SSRO (n=7), Le Fort I osteotomy & SSRO (n=17). *Two groups:* 1- with TMD symptoms (12 patients), 2- without TMD symptoms (12 patients) *Evaluated variables:* TMJ (clicking or crepitation), TMJ and masticatory muscles tenderness, maximum interincisal opening and maximum mouth opening. *Results:* • Patient with TMD symptoms: (TMJ sound, TMJ pain, masticatory muscles pain, limited mouth opening: 6 months post-surgery: 9 symptomatic patients and 3 asymptomatic patients. • Patients without TMD symptoms: 6 months post-surgery: 1 symptomatic patient and 11 asymptomatic patients. *Conclusion:* Postoperative TMD symptoms may be influenced mainly by preoperative TMD symptoms rather than mandibular setback using SSRO with rigid fixation.
14	*Author, year of publication:* Di Paolo et al, 2017 [25]. *Type of orthognathic surgery:* BSSO (n=12), with condylar position devices (n=6); Le Fort I + BSSO (n=64), and with condylar position devices (n=15). *Evaluated variables:* TMD prevalence, diffusion of the joints and muscular pain, as well as pain intensity levels in the joints using VAS scale[1] *Results:* • TMJ pain: Prior to surgery: 33.33%, after surgery: 0.0%. • Prior to surgery: 61.8% had TMD symptoms, after surgery: 21.7%, of which 80.8% had arthralgia and disc dislocation with reduction, and 19.2% had muscular pain and limited mandibular movement. *Conclusion:* Both functional status and pain levels related to TMDs can be significantly improved with a multi-disciplinary approach. Surgeon's intervention needs to be modified in the presence of presurgical TMDs.
15	*Author, year of publication:* Antonarakis et al, 2017 [16]. *Type of orthognathic surgery:* Orthodontic and orthognathic surgery together Le Fort I osteotomy or BSSO. Le Fort I osteotomy (one-, two-, or three-piece) (n=29), BSSO for (n=4), combined Le Fort I osteotomy and BSSO (n=55) *Evaluated Variables:* The anamnestic questionnaire included questions on parafunctional habits (such as nail or pen biting), jaw function, and the subjective presence of pain or TMJ sounds. Clinical examination included TMJ palpation determining the presence of pain at rest and mouth opening; masticatory muscle palpation determining the presence of pain; maximal mouth opening; deviation at mouth opening; maximal mandibular protrusion and laterotrusion; and the presence of articular sounds on palpation (joint clicking or crepitus). *Result:* • TMDs were diagnosed pre-treatment in 55.7%, disc displacement was identified in 43.2%, myofascial pain was present in 23.9%. • The mean Helkimo indices were 0.53 for Ai and 0.99 for Di. • TMJ click and Bimaxillary Surgery (BSSO) were found to be predictors of the development of TMDs. • Parafunctional habits, pain on palpation of masticatory muscles, Le Fort I, age, gender, previous treatment for TMD, have no significant effect on the incidence of postoperative TMD. *Conclusion:* TMDs must be evaluated, monitored, and managed with caution in patients with Class III malocclusion presenting with pre-treatment joint clicking and who are planned for bimaxillary osteotomies.
16	*Author, year of publication:* Hashemi et al, 2018 [30]. *Type of orthognathic surgery:* BSSO. *Evaluated Variables:* TMJ pain, click sound and maximum mouth opening *Result:* • TMJ pain: Pre surgery: 11.1%, 6 months post surgery: 7.4% (P=0.02). • Click sound: Pre surgery: 34.6%, 6 months post surgery: 23.5% (P=0.004). • Mean maximum mouth opening: Pre surgery 47.6mm, 6 months post surgery: 40.1 mm (p=0.0001). *Conclusion:* Orthognathic surgery has no significant effect on the limitation of maximum mouth opening, it improves TMJ pain and temporomandibular click of patients with Cl II malocclusion.

[1] visual analog scale (VAS).

17	*Author, year of publication:* AlWarawreh et al, 2018 [26]. *Type of orthognathic surgery:* Le Fort I+BSSO. *Evaluated Variables:* Click, pain, crepitus, MRI findings. *Result:* • Pain: Pre surgery: 8%, 1 year post surgery: 4%, improved: 7%, unchanged: 90%, worsened: 3%. • Click sound: Pre surgery: 27%, 1 year post surgery: 20%, improved: 19%, unchanged: 69%, worsened: 12%. • Crepitus: Pre surgery: 4%, 1 year post surgery: 3%, improved: 4%, unchanged: 93%, worsened: 3%. • MRI findings: Pre surgery: 7%, 1 year post surgery: 3%, improved: 4%, unchanged: 96%, worsened: 0%. • In class II: With preoperative TMD symptoms: 16 patients with postoperative TMD symptoms: 15 patients. • Class III: With preoperative TMD symptoms: 19 patients with postoperative TMD symptoms: 12 patients. *Conclusion:* TMD problems can occur in a variety of patients, including those who have facial deformities, and require orthognathic surgery. However, orthognathic surgery may not predictably treat or reduce the symptoms of TMD.
18	*Author, year of publication:* Kretschmer et al, 2019 [27]. *Type of orthognathic surgery:* Le Fort I+BSSO. *Evaluated Variables:* Overjet, overbite, maximal mouth opening, maximal protrusion, maximal lateral movement to both sides, pain on palpation, clicking, and crepitus. *Result:* • Significant reduction in pain on palpation (p=0.04). • Significant reduction clicking (p=0.01). • Significant reduction in maximum mouth opening (49mm before surgery and 48 mm after surgery) (p=0.003). • Significant reduction in protrusion (p=0.000). • Minimum but significant reduction in lateral movement to the right (p=0.001). • No significant change in lateral movement to the right (p=0.159). • No significant change in Crepitus (p=0.10). • Gender (p=0.04), and overjet (p=0.001), have a significant effect on preoperative pain. • Preoperative crepitus was effective in postoperative pain (p=0.001). • None of the variables affected preoperative crepitation and clicks. • None of the variables affected postoperative crepitation. • Preoperative clicking had a significant influence on postoperative clicking (p=0.001). • Occlusal stability (postoperative overjet and overbite) did not affect postoperative symptoms in temporomandibular joint, including the presence or absence of pain, the presence or absence of clicks, and the presence or absence of Crepitus. *Conclusion:* Orthognathic surgery has a beneficial effect on dysfunction of the TMJ as it reduces pain and clicking considerably. Patients should be informed, however, that TMJ disorders could still develop even if they had no symptoms preoperatively.
19	*Author, year of publication:* Sefidroodi et al, 2019 [35]. *Type of orthognathic surgery:* Six weeks of intermaxillary fixation + Mandibular setback surgery. *Evaluated Variables:* Helkimo clinical dysfunction index includes: an evaluation of TMJ function, range of movement, occasional pain during function, and pain upon palpation of the joint or masticatory muscles. The deep and superficial parts of the masseter muscle, anterior and posterior part of the temporal muscle and its attachment to the coronoid process, and the lateral and medial pterygoid muscles were subjects to examination. The questionnaire included five questions concerning pain and symptoms from the TMJs and masticatory muscles: pain during chewing/mouth opening, joint sounds such as crepitation and/or clicking, restricted mouth opening, and jaw fatigue. *Results:* 10 to 15 years after surgery • Maximum mouth opening: 50.1mm • TMJ function: 81% with straight opening and closing path, 19% lateral deviation, 33% with joint click. • Muscle pain: All patients experienced pain on palpation of one or more masticatory muscles. 72% of the patients had 1-3 muscles that were painful upon palpation, while 28% of the patients felt pain on palpation in four or more palpated muscles. Patients with masseter or temporal muscle tenderness did not show any reduction in mouth opening. • Pain on palpation of the TMJs: 31% of the patients reported pain on palpation of the TMJ either uni- or bilaterally. • Pain during jaw movements: The majority of patients 69.4% reported no pain on any movement of the mandible. Ten patients 27.8% experienced pain on maximum opening of the mouth, and four patients 11.1% reported pain during lateral movements or protrusion. • Helkimo dysfunction score=4 *Conclusion:* Ten to fifteen years after mandibular setback surgery the patient's mandibular range of movement is good. Despite clinically recognizable symptoms, few patients reported having TMJ- or masticatory muscle-related symptoms in their daily life.

20	*Author, year of publication:* Bruguiere et al, 2019 [38]. *Type of orthognathic surgery:* Orthodontic treatment and orthognathic surgery. *Evaluated Variables:* Myofascial pain with or without limited mouth opening (MYALGIA), arthralgia, disc displacement with reduction, and disc displacement with reduction with intermittent locking. *Results:* • 89.9% of patients exhibited pre-operative presence of orofacial parafunctions, 29.3% patients had at least one TMD symptom before surgery. • Significant relationship was found between postoperative myalgia and bruxism, dysfunctional swallowing, as well as tongue thrusting. • A significant association between the presence of any dysfunctional oral habit and the presence of DDR. • Thirty patients exhibited the occurrence of at least one new TMD symptom after surgery. However, no significant association was found between the presence of orofacial dysfunction or parafunction and the appearance of at least one TMD symptom after surgery. *Conclusion:* Bruxism and dysfunctional oral habits were shown to be risk factors for the presence of TMD symptoms also after combined orthodontic and surgical treatment. Treating such habits before orthognathic surgery should help prevent TMD.
21	*Author, year of publication:* Ploder et al, 2020 [28]. *Type of orthognathic surgery:* Bilateral SSO (n=173), Le Fort I+Bilateral SSO (n=202). *Evaluated Variables:* Mouth opening, pain, click, crepitus, type of surgery. *Results:* • Reduction in mouth opening one (45.1mm) and two years (46.7mm) post surgery compared to per surgery (47.2mm). • Pre surgery pain in 13.6%, two years post surgery in 10.3%. • Pre surgery click in 24.8%, two years post surgery in 20.5%. • Pre surgery crepitus in 1.3%, two years post surgery in 4.1%. • No significant difference between the mandibular setback or advancement surgery on TMDs symptoms. *Conclusion:* In most cases TMD symptoms can be significantly reduced and only a few can be induced with OGS. No risk factors were found for long-term effects on the TMJ.

Discussion

The temporomandibular joint (TMJ) is considered to be the most complex joint in the human body and is responsible for mandibular movements. The temporomandibular joint must coordinate with the occlusion, and with muscular and cervical changes. Maladaptation of the TMJ with said structures is what causes TMJ dysfunction, causing clinical signs and symptoms affecting the masticatory muscles and associated structures of the TMJ. This malfunction and clinical picture is clinically referred to as temporomandibular disease (TMD) [36]. It was found that TMD was higher in patients with dentofacial disharmonies compared to a matched control group. According to the Helkimo index, most patients with dentofacial anomalies initially, have moderate to severe TMD [39]. Although all methods involve osteotomies and fixations, oral and maxillofacial surgeons utilise several techniques of orthognathic surgery to correct malfunction and aesthetic deformities caused by dentofacial malformations [40]. Orthognathic surgery has a well-established role in the correction of dentofacial deformities [34]. Numerous studies have reported relieved TMD symptoms following the orthognathic surgery [27]. Several other studies, however, have found no benefit, or even an exacerbation of symptoms. Surgical movement of the maxilla via Le Fort I osteotomy and the mandible via ramus osteotomy are some of the performed routine orthognathic surgical procedures. Le Fort I osteotomy has little effect on TMJ dysfunction or mandibular movement and is not associated with direct trauma to the TMJ or masticatory musculature. SSRO may require monitoring due to the changes it causes in the condylar position. Evaluation of the condylar position alone, however, is insufficient without assessment of the disc-condylar position, as it is an important parameter in TMJ morphology changes and accompanying symptoms [34].

Pain and sound

Some studies reported that orthognathic surgery has an effect on myofascial pain and arthralgia as well as on TMJ sounds [20][30][32][37]. Jung et al. reported improvement of TMJ pain and Sound in patients with Class III malocclusion following sagittal split osteotomy and vertical ramus osteotomy [41]. Scolozzi et al. Found that pain in the masticatory muscles before surgery was a predictor of TMD Di after orthognathic surgery [23]. Hashemi et al. also reported that BSSO

surgery significantly reduced pain and noise in patients who have had pre-surgery TMD symptoms [30]. Yoon et al reported that Le Fort I+BSSRO surgery significantly reduced TMJ noise [32]. AlWarawreh et al. found that orthognathic surgery improved pain. [26]. Kretschmer et al reported that Le Fort I+BSSO surgery significantly reduce postoperative pain [27]. Di Paolo et al. also reported that orthognathic surgery reduces postoperative pain [25].

Tenderness and click

Some studies have reported that orthognathic surgery may positively affect TMJ dysfunction and pain levels following the surgery, while some dysgnathic patients may develop TMJ disorder after surgery, having been asymptotic preoperatively [20]. AlWarawreh et al. found that orthognathic surgery improves clicks [26]. Scolozzi et al. found that TMJ clicks were a predictor of TMD Ai after orthognathic surgery [23]. Kretschmer et al reported that Le Fort I+BSSO surgery significantly reduce postoperative clicks. And the presence of preoperative clicks had a significant effect on the existence of postoperative clicks [27].

Mouth opening

Some studies have reported that orthognathic surgery can have a positive effect on the rate of mouth opening [20][22]. However, Abrahamsson et al. reported a 2 mm reduction in mouth opening after bilateral orthognathic bilateral vertical ramus osteotomy (with or without maxillary osteotomy), which is minor and clinically insignificant [37]. Hashemi et al. also reported that BSSO surgery significantly reduced the rate of mouth opening [30]. Kretschmer et al reported that Le Fort I+BSSO surgery significantly reduce mouth opening after surgery [27]. The reduction in the mouth opening could be due to surgical trauma to the tissue, or perhaps a consequence of jaw immobilization via postoperative maxillo-mandibular fixation [37]. Atrophy and scarring of the muscles and connectives tissues may also play a role in the post-surgical hypomobility. Furthermore, TMJ disorders are regarded as a multifaceted condition that can be influenced by a variety of physical, psychological, and social factors [20].

Asymptomatic patients

There is a low risk of post-surgical TMJ disorder development in previously asymptomatic dysgnathic patients [20][22][26]. AlWarawreh et al. found that othognathic surgery may cause TMD symptoms [26]. However, Yoon et al. reported that Le Fort I+BSSRO surgery improved TMD symptoms in patients who did not have TMD symptoms before surgery [32]. Scolozzi et al. mentioned that pain in the masticatory muscles before surgery was a predictor of TMD Di after orthognathic surgery [23]. These results highlight the importance of diagnosing TMJ clicks and pain of muscles on palpation.

Bruxism and parafunctional habits

Bruxism and dysfunctional oral habits are regarded as potential risk factors for the development of TMD symptoms despite combined orthodontic and surgical treatment. TMD in said patients can be prevented by treating the mentioned habits prior to surgery [38].

Occlusion

TMJ symptoms vary considerably between patients in accordance to the various types of dento-facial deformities. Class II patients or mandibular retrognathia displayed a higher rate of infliction [20]. Westermark et al. also reported that TMJ symptoms were higher in retrogenism patients than in prognathism patients. [13]. De Clercq et al. reported that patients with class II deformities, low angle and deep bite, were more frequently ailed with TMJ disorders [42]. Togashi et al displayed that the signs and symptoms of TMD were associated with dentofacial deformities and retrograde and mandibular asymmetry [22]. This is due to the high condylar compressive loadings during function and different vector of compressive loading on class II and deep bite patient [20]. It has been postulated that in patients with Class II deep bites, the disc is subjected to greater compressive loads during mastication and renders anteriorly more than it would in patients with a normal occlusion. In patients with asymmetry, a similar condition may develop in the joint on the deviated side of the mandible. However, this hypothesis is not supported with conclusive evidence, as it was also reported that occlusal conditions had no clear link with TMJ disorder signs and symptoms. Another possibility is that degenerative joint disease, which is caused by internal derangement, may have a role in the development mandibular retrusion or asymmetry. It has been also been proposed that TMJ degeneration may lead to dentofacial anomalies such as open bite, asymmetry, and mandibular retrusion. It was reported, however, that TMJ involvement did not always lead to craniofacial growth disturbances [22]. However, the results of Dujoncquoy et al. Showed that there were no differences between TMJ symptoms in class II and class III patients [20].

Type of Performed Surgery

The signs and symptoms of TMD have been reported to improve more after Le Fort I and mandibular setback than for mandibular advancement [14][22]. In this regard, Yoon et al. showed that jaw surgery is beneficial regardless of whether TMJ symptoms were treated prior to surgery [32]. Takahara et al. showed that the symptoms of TMD after mandibular setback surgery are not similar to mandibular advancement and the type of surgery affects those symptoms [34]. However, the findings of Togashi et al. [22] and Kerestens et al. [43] stated that there was no significant difference regarding the type of surgery performed. The effect of orthognathic surgery on the symptoms of TMD is unpredictable due to the different results reported by studies. Finally, it seems that assessing TMJ by a trained specialist based on the RDC/TMD guideline can help the surgeon inform the patient about the risk of improving or worsening TMD symptoms.

Conclusion

Studies have reported decreased mouth opening, decreased pain, decreased clicking, and decreased joint sounds after orthognathic surgery. TMJ also had a high predictive value in orthognathic patients. Due to the fact that there are varied results of the studies, which could be due to the lack of careful examination of the TMJ joint before surgery, lack of regular follow-up, or perhaps problems during maxillofacial osteotomy, which were not mentioned in the studies. Finally, it is suggested that the studies should be performed with a more detailed examination of the jaw joint before surgery and the patient's problems pre- and post- surgery should be recorded with clinical examinations and radiographs. Moreover, more comprehensive studies should be performed with the aim of examining the effects of each surgical technique and more closely examining the problems of the jaw joint for patients. Perform regular follow ups for these patients before and after surgery.

Conflict of Interest

There is no conflict of interest to declare.

References

[1] Te Veldhuis E, Te Veldhuis A, Bramer W, Wolvius E, Koudstaal M. The effect of orthognathic surgery on the temporomandibular joint and oral function: a systematic review. Int J Oral Maxillofac Surg. 2017; 46 (5): 554-63.

[2] Al-Zubair NM. Dental arch asymmetry. Eur J Dent. 2014; 8 (2): 224-28.

[3] Janson GR, Metaxas A, Woodside DG, de Freitas MR, Pinzan A. Three-dimensional evaluation of skeletal and dental asymmetries in Class II subdivision malocclusions. Am J Orthod Dentofacial Orthop. 2001; 119 (4): 406-18.

[4] Nie Q, Lin J. [Analysis and comparison of dental arch symmetry between different Angle's malocclusion categories and normal occlusion]. Zhonghua Kou Qiang Yi Xue Za Zhi. 2000; 35 (2): 105-7.

[5] Freihofer HP. Surgical treatment of the short face syndrome. J Oral Surg. 1981; 39 (11): 907-11.

[6] Bansal AK, Sharma M, Kumar P, Nehra K, Kumar S. Long face syndrome: a literature review. J Dent Health Oral Disord Ther. 2015; 2 (6): 210-13.

[7] Thaller S. Introduction to orthognathic surgery. J Craniofac Surg. 2007; 18 (4): 715-17.

[8] Sarver DM, Proffit WR, Ackerman J. Diagnosis and treatment planning in orthodontics. Orthodontics, current principles and techniques 3rd ed St Louis: Mosby. 2000; 27: 128.

[9] Mina K, Paniz A, Farnoosh R, Keyhan S. Temporomandibular joint disorder therapy: A review. J Craniomaxillofac Res. 2020; 7 (3): 110-25.

[10] Rutkiewicz T, Könönen M, Suominen-Taipale L, Nordblad A, Alanen P. Occurrence of Clinical Signs of Temporomandibular Disorders in Adult Finns. J Orofac Pain. 2006; 20 (3): 208-17.

[11] Malik P, Rathee M, Sehrawat R. Temporomandibular disorders and their management. Am J Health Res. 2015; 3 (3-2): 1-5.

[12] Buescher JJ. Temporomandibular joint disorders. American family physician. 2007; 76 (10): 1477-82.

[13] Westermark A, Shayeghi F, Thor A. Temporomandibular dysfunction in 1,516 patients before and after orthognathic surgery. Int J Adult Orthodon Orthognath Surg. 2001; 16 (2): 145-51.

[14] Dervis E, Tuncer E. Long-term evaluations of temporomandibular disorders in patients undergoing orthognathic surgery compared with a control group. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002; 94 (5): 554-60.

[15] Kim Y-K, Yun P-Y, Ahn J-Y, Kim J-W, Kim S-G. Changes in the temporomandibular joint disc position after orthognathic surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2009; 108 (1): 15-21.

[16] Antonarakis GS, Kalberer N, Courvoisier DS, Scolozzi P. Clinical predictive factors for temporomandibular disorders following combined orthodontic and orthognathic surgical treatment in patients with Class III malocclusion. Cranio. 2017; 35 (6): 397-404.

[17] Al-Moraissi EA, Wolford LM, Perez D, Laskin DM, Ellis III E. Does orthognathic surgery cause or cure temporomandibular disorders? A systematic review and meta-analysis. J Oral Maxillofac Surg. 2017; 75 (9): 1835-47.

[18] Rani S, Pawah S, Gola S, Bakshi M. Analysis of Helkimo index for temporomandibular disorder diagnosis in the dental students of Faridabad city: A cross-sectional study. J Indian Prosthodont Soc. 2017; 17 (1): 48-52.

[19] Ohrbach R, Turner JA, Sherman JJ, Mancl LA, Truelove EL, Schiffman EL, et al. Research diagnostic criteria for temporomandibular disorders: evaluation of psychometric properties of the axis II measures. J Orofac Pain. 2010; 24 (1): 48-62.

[20] Dujoncquoy J-P, Ferri J, Raoul G, Kleinheinz J. Temporomandibular joint dysfunction and orthognathic surgery: a retrospective study. Head & face medicine. 2010; 6 (1): 27-32.

[21] Ramieri G, Piancino MG, Frongia G, Gerbino G, Fontana PA, Debernardi C, et al. Clinical and instrumental evaluation of the temporomandibular joint before and after surgical correction of asymptomatic skeletal class III patients. J Craniofac Surg. 2011; 22 (2): 527-31.

[22] Togashi M, Kobayashi T, Hasebe D, Funayama A, Mikami T, Saito I, et al. Effects of surgical orthodontic treatment for dentofacial deformities on signs and symptoms of temporomandibular joint. J Oral Maxillofac Surg Med Pathol. 2013; 25 (1): 18-23.

[23] Scolozzi P, Wandeler PA, Courvoisier DS. Can clinical factors predict postoperative temporomandibular disorders in orthognathic patients? A retrospective study of 219 patients. Oral Surg Oral Med Oral Pathol Oral Radiol. 2015; 119 (5): 531-8.

[24] Sebastiani AM, Baratto-Filho F, Bonotto D, Kluppel LE, Rebellato NL, da Costa DJ, et al. Influence of orthognathic surgery for symptoms of temporomandibular dysfunction. Oral Surg Oral Med Oral Pathol Oral Radiol. 2016; 121 (2): 119-25.

[25] Di Paolo C, Pompa G, Arangio P, di Nunno A, Di Carlo S, Rosella D, et al. Evaluation of Temporomandibular Disorders before and after Orthognathic Surgery: Therapeutic Considerations on a Sample of 76 Patients. J Int Soc Prev Community Dent. 2017; 7 (2): 125-29.

[26] AlWarawreh AM, AlTamimi ZH, Khraisat HM, Kretschmer W. Prevalence of Temporomandibular Disorder Symptoms among Orthognathic Patients in Southern Germany: Retrospective Study. Int J Dent. 2018; 2018: 1-5.

[27] Kretschmer W, Baciuţ G, Baciuţ M, Sader R. Effect of bimaxillary orthognathic surgery on dysfunction of the temporomandibular joint: a retrospective study of 500 consecutive cases. Br J Oral Maxillofac Surg. 2019; 57 (8): 734-39.

[28] Ploder O, Sigron G, Adekunle A, Burger-Krebes L, Haller B, Kolk A. The Effect of Orthognathic Surgery on Temporomandibular Joint Function and Symptoms: What are the Risk Factors? A Longitudinal Analysis of 375 Patients. J Oral Maxillofac Surg. 2020: 1-13.

[29] Kuhlefelt M, Laine P, Thorén H. Bilateral sagittal split surgery is not a predictable treatment for temporomandibular dysfunction in patients with retrognathia. Oral Surg Oral Med Oral Pathol Oral Radiol. 2016; 121 (6): 595-601.

[30] Hashemi HM, Fakhari S, Avval SK. The effect of mandibular advancement on signs and symptoms of the temporomandibular joint. J Craniomax Res. 2018; 5 (4): 169-73.

[31] Kim YK, Kim SG, Kim JH, Yun PY, Oh JS. Temporomandibular joint and psychosocial evaluation of patients after orthognathic surgery: a preliminary study. J Craniomaxillofac Surg. 2013; 41 (5): e83-6.

[32] Yoon S-Y, Song J-M, Kim Y-D, Chung I-K, Shin S-H. Clinical changes of TMD and condyle stability after two jaw surgery with and without preceding TMD treatments in class III patients. Maxillofac Plast Reconstr Surg. 2015; 37 (1): 1-7.

[33] Christovam ERP, Boeck EM, Vedovello SAS, Valdrighi HC, Degan VV, Vedovello Filho M. Signs and symptoms of temporomandibular disorder and patients' satisfaction before and after orthognathic surgery. Brazi J Oral Sci. 2016: 137-43.

[34] Takahara N, Kabasawa Y, Sato M, Tetsumura A, Kurabayashi T, Omura K. MRI changes in the temporomandibular joint following mandibular setback surgery using sagittal split ramus osteotomy with rigid fixation. Cranio. 2017; 35 (1): 38-45.

[35] Sefidroodi M, Lobekk OK, Løes S, Schilbred Eriksen E. Temporomandibular joint function 10-15 years after mandibular setback surgery and six weeks of intermaxillary fixation. J Appl Oral Sci. 2019; 27: 1-7.

[36] Silva M, Ferreira AT, Migliorucci RR, Nari Filho H, Berretin-Felix G. Influence of orthodontic-surgical treatment on signs and symptoms of temporomandibular dysfunction in subjects with dentofacial deformities. Rev Soc Bras Fonoaudiol. 2011; 16 (1): 80-4.

[37] Abrahamsson C, Henrikson T, Nilner M, Sunzel B, Bondemark L, Ekberg E. TMD before and after correction of dentofacial deformities by orthodontic and orthognathic treatment. Int J Oral Maxillofac Surg. 2013; 42 (6): 752-58.

[38] Bruguiere F, Sciote JJ, Roland-Billecart T, Raoul G, Machuron F, Ferri J, et al. Pre-operative parafunctional or dysfunctional oral habits are associated with the temporomandibular disorders after orthognathic surgery: An observational cohort study. J Oral Rehabil. 2019; 46 (4): 321-29.

[39] Song YLBMMOR, Yap AUBMP. Orthognathic treatment of dentofacial disharmonies: its impact on temporomandibular disorders, quality of life, and psychosocial wellness. Cranio. 2017; 35 (1): 52-57.

[40] Nunes de Lima V, Faverani LP, Santiago JF, Jr., Palmieri C, Jr., Magro Filho O, Pellizzer EP. Evaluation of condylar resorption rates after orthognathic surgery in class II and III dentofacial deformities: A systematic review. J Craniomaxillofac Surg. 2018; 46 (4): 668-73.

[41] Jung HD, Jung YS, Park HS. The chronologic prevalence of temporomandibular joint disorders associated with bilateral intraoral vertical ramus osteotomy. J Oral Maxillofac Surg. 2009; 67 (4): 797-803.

[42] De Clercq CA, Neyt LF, Mommaerts MY, Abeloos JV, De Mot BM. Condylar resorption in orthognathic surgery: a retrospective study. Int J Adult Orthodon Orthognath Surg. 1994; 9 (3): 233-40.

[43] Kerstens HC, Tuinzing DB, van der Kwast WA. Temporomandibular joint symptoms in orthognathic surgery. J Craniomaxillofac Surg. 1989; 17 (5): 215-8.

[44] Mehraban SH, Jamali S, Azizi A, Nasrabadi N. Evaluating the effectiveness of orthognathic surgery on the pre-existing temporomandibular disorders in patients with malocclusion: A systematic review and meta-analysis. Pesqui Bras Odontopediatria Clín Integr. 2020; 20: 1-8.

[45] Jędrzejewski M, Smektała T, Sporniak-Tutak K, Olszewski R. Preoperative, intraoperative, and postoperative complications in orthognathic surgery: a systematic review. Clin Oral Investig. 2015; 19 (5): 969-77.

[46] Bermell-Baviera A, Bellot-Arcís C, Montiel-Company JM, Almerich-Silla JM. Effects of mandibular advancement surgery on the temporomandibular joint and muscular and articular adaptive changes--a systematic review. Int J Oral Maxillofac Surg. 2016; 45 (5): 545-52.

[47] Lindenmeyer A, Sutcliffe P, Eghtessad M, Goulden R, Speculand B, Harris M. Oral and maxillofacial surgery and chronic painful temporomandibular disorders--a systematic review. J Oral Maxillofac Surg. 2010; 68 (11): 2755-64.

[48] Mladenović I, Jović N, Čutović T, Mladenović G, Kozomara R. Temporomandibular disorders after orthognathic surgery in patients with mandibular prognathism with depression as a risk factor. Acta Odontologica Scandinavica. 2013; 71 (1): 57-64.

Please cite this paper as:
Khayamzadeh M, Razmara F, Salehi Karizmeh M; Evaluation of the temporomandibular disorders after orthognathic surgeries: A review. J Craniomax Res 2022; 9(1): 1-18