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Review Article

ORTHOGNATHIC SURGERY EFFECT ON TEMPOROMANDIBULAR JOINT (TMJ PAIN AND TMJ SOUND): A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Dentofacial deformity refers to significant abnormalities in the alignment of the maxillomandibular complex, which can affect both the teeth's positioning within the arches and the relationship between the upper and lower jaws (occlusion). These deformities are more common in women (60.93%). Orthognathic surgery, which includes procedures like Le Fort I, Bilateral Sagittal Split Osteotomy (BSSO), and Intraoral Vertical Ramus Osteotomy (IVRO), is commonly performed to correct these deformities. However, the impact of such surgery on temporomandibular joint (TMJ) conditions remains still unclear. The purpose of this systematic review was to determine whether orthognathic surgery impact on temporomandibular joint (TMJ) conditions. Using the PICO framework, we conducted an extensive search of PubMed and Google Scholar for relevant studies published between 2015 and 2024. These studies assessed a total 859 abstracts, 10 studies met our inclusion criteria. Of these, 6 studies reported improvements in TMJ pain, and 7 studies reported improvements in TMJ sounds post-surgery. However, 2 studies noted a worsening of TMJ pain and 1 study observed worsened TMJ sounds. Additionally, 2 studies no improvement/stables in TMJ pain. Overall, while orthognathic surgery tends to improve TMJ conditions, there are instances where symptoms may worsen. Careful pre-surgical planning and patient selection are crucial to optimizing outcomes and minimizing the risk of adverse effects on TMJ health.

Keywords: Dentofacial deformity, orthognathic surgery, TMJ, TMJ pain, TMJ sound

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INTRODUCTION

Dentofacial Deformities (DFDs) pose a formidable and complex challenge in the field of oral and maxillofacial surgery, particularly when considering the profound implications of orthognathic surgery to restore balance and harmony. These deformities are characterized by striking abnormalities in the proportions of the maxillomandibular complex, disrupting not only the alignment of the teeth within each arch but also the intricate relationship between the upper and lower arches (occlusion) [1, 2]. Remarkably, studies reveal that women are disproportionately affected, with a striking 60.93% of cases occurring in females [3].

Orthognathic Surgery (OGS) stands as a transformative and highly regarded procedure aimed at reshaping and correcting the intricate structures of the face. This surgical intervention is typically classified into three primary categories: maxillary surgery, mandibular surgery, and combined bimaxillary surgery.

In the maxilla, the Le Fort I osteotomy is the most commonly employed approach. This procedure involves a horizontal osteotomy of the maxillary bone at the level of the nasal floor, allowing repositioning of the maxilla in anterior, posterior, superior, or inferior directions, as well as rotational movements. The Le Fort I osteotomy is effective in managing cases such as maxillary deficiency, anterior open bite, and vertical maxillary excess.

In contrast, several techniques are available for the mandible, depending on the patient's clinical needs. The Bilateral Sagittal Split Osteotomy (BSSO), also known as the Bilateral Sagittal Split Ramus Osteotomy (BSSRO), is the standard technique for correcting mandibular prognathism or retrognathism. This procedure involves sagittal splitting of the mandibular rami bilaterally, enabling advancement or setback of the mandible. The repositioned segments are stabilized using miniplates and screws to achieve postoperative stability. An alternative is the Sagittal Split Ramus Osteotomy (SSRO), which may be performed unilaterally or bilaterally, depending on the degree of correction required. Additionally, the Intraoral Vertical Ramus Osteotomy (IVRO) is a technique that involves a vertical cut through the mandibular ramus via an intraoral approach, typically without rigid fixation. IVRO is often indicated in mild retrognathia cases or in patients with temporomandibular joint (TMJ) disorders, and generally requires postoperative intermaxillary fixation (IMF).

For complex skeletal deformities involving both jaws, a Bimaxillary Osteotomy (BIJAW) is performed, which combines a Le Fort I osteotomy for the maxilla and either a BSSO or IVRO for the mandible. This approach allows comprehensive correction of occlusal relationships and overall facial balance. Bimaxillary osteotomies are typically indicated for patients with severe skeletal Class II or Class III malocclusions, significant facial asymmetry, or complex craniofacial anomalies. This technique requires meticulous preoperative planning, often incorporating digital surgical simulation to optimize both functional and aesthetic outcomes.

The primary objectives of OGS are to enhance functional outcomes, such as correcting malocclusion, improving mastication, speech, and respiration, and alleviating sleep apnea-while also reducing treatment time, ensuring long-term stability after orthodontic procedures, preventing relapse, and enhancing facial aesthetics. Additionally, OGS plays a crucial role in safeguarding the health and function of the temporomandibular joint (TMJ) [4].

The relationship between OGS and TMJ conditions is complex, as the surgery can both alleviate and exacerbate TMJ symptoms [5, 6]. Patients with temporomandibular disorders (TMD) may experience improvement in temporomandibular joint (TMJ) function following orthognathic surgery. This is particularly evident in individuals with dento-skeletal deformities, where occlusion is often misaligned, characterized by a lack of interlocking, absence of cusp-to-fossa relationships, and poor occlusal contacts. These factors can contribute to increased occlusal load and stress on the articular disc, which are key contributors to the development of TMD. Surgical procedures can help reposition the condyle appropriately, thereby reducing excessive joint pressure and leading to TMJ symptom improvement in many patients.

However, in a small number of cases, patients may experience worsening of TMD symptoms postoperatively. One of the potential

causes of this outcome is improper placement of fixation plates during bilateral sagittal split ramus osteotomy (BSSRO). If the fixation is not established in centric occlusion, it may result in new or aggravated signs and symptoms of TMD. In centric occlusion, the condyle should be positioned as far posteriorly as possible within the glenoid fossa. In orthognathic surgery, it is the anterior segment of the mandible that should be moved-whether through advancement, setback, or rotation-while the posterior segment, including the condyle, must remain unaltered. Alterations in the posterior segment can lead to postoperative TMJ pain or discomfort in the surrounding muscles (Choi *et al.*, 2013).

Therefore, it is essential that surgeons preserve the original position of the condyle when placing fixation plates, particularly in patients who did not present with TMD symptoms before surgery.

Research indicates that the effects of OGS on TMJ conditions, particularly joint pain and sounds, are variable. Some studies have shown significant improvements in TMJ function and a reduction in joint sounds following surgery. Patients with mandibular prognathism experienced a statistically significant reduction in both joint sounds and pain after undergoing vertical ramus osteotomy [7]. Conversely, other studies suggest that OGS may not always lead to improvements in TMJ symptoms, particularly in patients with pre-existing TMJ disorders [8]. This inconsistency highlights the need for careful preoperative assessment and planning to mitigate potential complications related to TMJ function. The purpose of this systematic review is to describe pre-and post-surgery TMJ conditions in patients who undergo Le Fort I, BSSO, BSSRO, SSRO or and IVRO procedures, with the goal of evaluating whether orthognathic surgery improves, maintains, or worsens TMJ conditions.

MATERIALS AND METHODS

This systematic literature review protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO ID: CRD420251011183). This approach was agreed with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-P). This study utilized the Systematic Literature Review (SLR) method to evaluate the impact of orthognathic surgery, particularly Le Fort I**,** Bilateral Sagittal Split Osteotomy (BSSO)**,** Bilateral Sagittal Split Ramus Osteotomy (BSSRO), Sagittal Split Ramus Osteotomy (SSRO) and Intraoral Vertical Ramus Osteotomy (IVRO)**,** on the condition of Temporomandibular Joint (TMJ). This systematic review was conducted according to the guidelines of the PRISMA (fig. 1).

Focus question

In this study, the PICO framework was used to guide the literature search and selection process. The population (P) examined includes patients with dentofacial deformity (class II and clas III sceletal) undergoing orthognathic surgery, with the intervention (I) involving Le Fort I**,** BSSO**,** BSSRO, SSRO or and IVRO surgeries. The comparison (C) involves the TMJ conditions before and after surgery, and the outcome (O) measured is the change in TMJ condition involve TMJ sound (clicking/crepitus/popping) and TMJ pain**.** The types of studies (S) included were cohort prospective, retrospective studies. A research question was formulated following the Population, Intervention, Control, and Outcome (PICO) framework: "Does orthognathic surgery affects temporomandibular joint pain and sounds ?" This review evaluate whether there is improvement, worsening, or no change in TMJ conditions. This research includes literature published in the last 10 y (December 2015-December 2024) to ensure that the data used is both relevant and current, focusing on studies published in English and conducted on human subjects**.**

Literature research

The literature search was conducted across several electronic databases, including:

- PubMed (679 results), using keyword combinations such as: ((temporomandibular disorder) OR (TMD) or (TMJ) or (temporomandibular joint) AND ((orthognathic surgery) or (orthognathic) or (BSSO) or (Le Fort 1) or (bi-jaw surgery) or (bimaxillary))
- Scopus (22 results): orthognathic surgery AND TMJ disorders AND (le AND fort AND i OR bsso OR bssro OR ssro OR ivro) AND PAIN AND SOUND
- Embase (0 results): orthognathic surgery AND TMJ disorders AND (le AND fort AND i OR bsso OR bssro OR ssro OR ivro) AND PAIN AND SOUND
- Cochrane (1 results): "orthognathic surgery" AND "temporomandibular joint disorder" AND ("le fort i" OR bsso OR bssro OR ssro OR ivro)
- Google Scholar (157 results), with keyword combinations such as: ((temporomandibular joint) OR (TMJ) OR (TMD) or (temporomandibular disorder)) AND ((orthognathic) OR (BSSO) OR (Le Fort I)) AND (Free Full Text) AND (English).

Screening process

After obtaining the articles, screening was carried out based on their titles and abstracts**.** Articles that met the inclusion criteria, which articles written in the English language, prospective studies, retrospective studies, articles published in the last 10 y, involve studies discussing patients undergoing orthognathic surgery and its effects on change in TMJ condition, involve TMJ sound (clicking/crepitus/popping) and TMJ pain were analyzed in depth. Animal studies, studies that did not involve Le Fort I**,** BSSO, BSSRO, SSRO, or and IVRO surgeries or did not report pre-and post-operative data on TMJ condition (TMJ sound and pain) were excluded from the analysis.

Data extraction and analysis

Data extraction involved collecting key information from each study, including **s**tudy design**,** population characteristics**,** the surgical methods used, and results related to TMJ conditions**.** The data was analyzed descriptively, and findings from similar studies in terms of design and measurement were consolidated for a comprehensive overview. This is crucial to ensure that the studies included in the analysis have a high level of validity and minimal bias. The final results of this review are expected to provide clear evidence on the impact of orthognathic surgery on TMJ conditions and to assist clinicians in making better decisions regarding surgical treatment for patients at risk of developing TMJ.

Selection criteria and data extraction

The data analysis was carried out by SC and HR, who served as the two primary evaluators. First, duplicate journals were removed, and the studies were initially screened to determine if they addressed the research question and objectives of the review. This first round of analysis relied on the information from each study's title, abstract, and keywords. In cases where the details were unclear or incomplete, the full text of the study was examined-if there was any uncertainty, the study was moved forward to the next phase of evaluation. In the second phase, after reading the full text of the articles, the evaluators ensured that each article met the inclusion criteria for the systematic review. Any disagreements between the reviewers were resolved by a third, experienced evaluator (RC), who independently reviewed the cases.

Quality assessment

The quality of included study protocols was assessed after study selection by investigating fulltext articles. JBI Critical Appraisal Checklist was used to assess the risk of bias, evaluating 11 questions (table 1).

RESULTS

The initial electronic search retrieved 836 articles. After removing duplicates identified through databases like PubMed and Google Scholar, 826 studies were excluded for not meeting the inclusion criteria. Following a thorough screening process, 10 studies remained eligible for further evaluation (fig. 1). These studies included both prospective and retrospective research involving

patients who underwent Le Fort I, BSSO, BSSRO, SSRO, or IVRO surgeries, and were analyzed in detail. In total, ten articles [9–18] were included. The studies, published between 2015 and 2022, focused on individuals with dentofacial deformities who were candidates for orthognathic surgery. A summary of the included studies is presented in table 2.

Study design

Out of the ten studies, seven were retrospective cohort studies [10–14, 17, 19] and three were prospective cohort studies [15, 16, 18].

Selection of patients

Total of 717 patients were assessed from 10 journals, all of whom had dentofacial deformities and underwent orthognathic surgery, with or without pre-existing TMJ issues (including TMJ pain and sounds), both before and after the surgery (table 3).

Treatment performed

From the table 3, the orthognathic surgery include Le Fort 1, BSSO, BSSRO, SSRO, or and IVRO. The patients evaluated before and after the surgery with different follow-up period from 3, 6, 12, until 24 mo.

Improvement of TMJ condition

-TMJ Pain

Improvements in TMJ conditions (TMJ pain) following Le Fort I, BSSO, BSSRO, SSRO, or IVRO surgeries were reported in six studies, with most patients experiencing a reduction in temporomandibular joint pain and an increase in jaw functionality (table 4) (11–13,15–17).

-TMJ Sound

Improvements in TMJ conditions (TMJ sound) following Le Fort I, BSSO, BSSRO, SSRO, or IVRO surgeries were reported in seven studies. Most patients experienced a reduction in temporomandibular joint sound and an increase in jaw functionality (table 5) [9–12, 15–17].

Worsening of TMJ conditions

-TMJ Pain

A worsening of TMJ symptoms (TMJ pain), including increased pain and dysfunction of the temporomandibular joint, was found in two studies. In these cases, the deterioration was typically linked to biomechanical factors or post-surgical mismatches, such as drastic changes in occlusion (table 4) [9, 14].

Table 1: Risk of bias

Question Study	1	2	3	4	5	6	7	8	9	10	11
Scolozzi *et al.*,2015	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	No	Yes
Yoon *et al.*, 2015	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Unclear	No	Yes
Antonarakis *et al.*, 2017	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Unclear	No	Yes
Zhai *et al.*, 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	No	Yes
Lekroengsin *et al.*, 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes
Park *et al.*, 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Unclear	Yes
Sahu *et al.*, 2022	Yes	Not Applicable	Yes	Yes	Yes	No	Yes	Yes	Unclear	Unclear	Yes
Kaur *et al.*, 2022	Yes	Not Applicable	Yes	Yes	Yes	No	Yes	Yes	Yes	Not Applicable	Yes
Chen *et al.*, 2022	Yes	Not Applicable	Yes	Yes	No	No	Yes	Yes	Yes	Not Applicable	Yes
Toh *et al.*, 2022	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	No	Yes

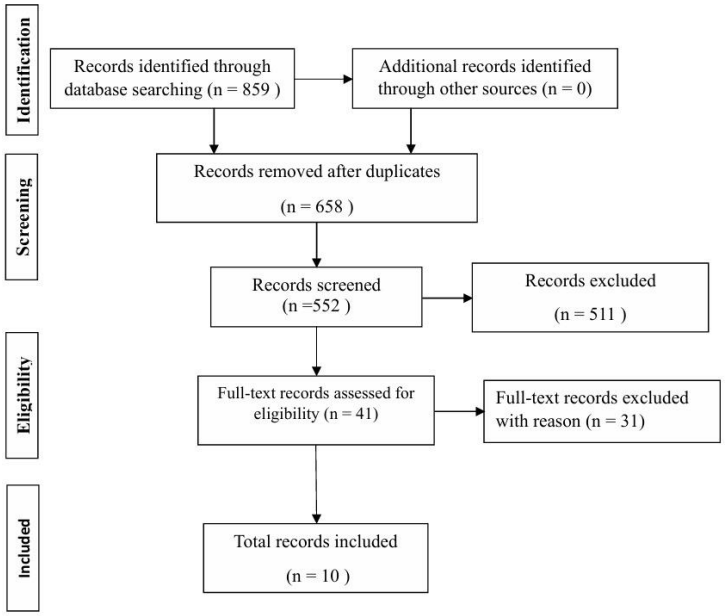

Fig. 1: PRISMA flow diagram of the screening and selection process

JBI critical appraisal checklist for cohort studies

1. Were the two groups similar and recruited from the same population?
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?
3. Was the exposure measured in a valid and reliable way?
4. Were confounding factors identified?
5. Were strategies to deal with confounding factors stated?
6. Were the groups/participants free of the outcome at the start of

the study (or at the moment of exposure)?

7. Were the outcomes measured in a valid and reliable way?

8. Was the follow-up time reported and sufficient to be long enough for outcomes to occur?

9. Was follow-up complete, and if not, were the reasons to loss to follow-up described and explored?

10. Were strategies to address incomplete follow-up utilized?

11. Was appropriate statistical analysis used?

Table 2: Data extraction

S. No.	Author	Year	Study design	Participant	Age range	Intervention	Observation period	Assesment method of outcomes	Limitation	Outcomes
1	Scolozzi P, Wandeler PA, Courvoisier DS	2015	Retrospective study	219 patients (96 male, 123 female) (1998-2012.	15-56 Y	- Le Fort I osteotomy 44 (20.2) -(BSSO) 51 (23.4) - Le Fort I+BSSO 124 (56.6)	Pre-operative 12 mo postoperative	RDC/TMD		Reduction: . TMJ sounds Increase: . TMJ Pain
2	Yoon YS, Song JM, Kim YD, Chung IK, Shin SH	2015	Retrospective Study	15 patients (7 males,8 females)	Mean age: 24.4±4.29 y, range: 18– 31y).	Bimaxillary surgery (LeFort1+BSSRO)	Pre-operatively 6 mo post-op	RDC/TMD		Reduction: . TMJ sound Stable: . TMJ pain
3	Antonarakis GS, Kalberer N, Courvoisier DS, Scolozzi P	2017	Retrospective cohort study	88 patients (39 male; 49 female)	mean age: 24.5±9.6 y	29 le Fort I osteotomy 4 BSSO 55 le Fort I osteotomy +BSSO	Pre-operatively 12 mo post-op	DC/TMD		Reduction: . TMJ pain . TMJ sound
4	Zhai Y, Han JJ, Jung S, Kook MS, Park HJ, Oh HK	2020	Retrospective cohort study	66 patients (38 male, 28 female)	Average: 21.3 y	Le Fort 1 BSSRO/SSRO Bimaxillary	Pre-operative 6 mo post-op		The author didn't use DC/TMD, and just check about clicking in TMJ sound	Reduction: . TMJ sound (clicking only) . TMJ pain
5	Lekroengsin B, Tachiki C, Takaki T, Nishii Y	2023	Retrospective study	30 patients (4 male, 26 female) (April 2007 – Maret 2017)	Average: 27, 2 y	14 BSSRO 16 BSSRO+LeFort 1 (Bimaxillary)	Pre-operative 1-2 y post op		The author didn't use DC/TMD, and didn't describe about TMJ sound	Increase: . TMJ Pain
6	Park J, Hong KE, Yun JE, Shin ES, Kim CH, Kim BJ, Kim JH	2021	Retrospective cohort study	82 patients	>18 y	Group I: SSRO+IVRO Group II: BSSRO	Pre-operative >3 mo post-op		The author didn't use DC/TMD	Reduction: . TMJ Pain Improvement: . TMJ sound
7	Sahu GR, Kaur A, Rattan V, Singh, SP, Rai S	2022	Prospective Study	56 patients (28 males and 28 females) (1st July 2013 – 30th June 2018)	19–35 y.	16 leFort 1 16 BSSO 24 Bimaxillary (LeFort 1+BSSO mandibular setback)	Pre-operatively 6 mo post-op	DC/TMD		Reduction: . TMJ sound . TMJ pain
8	Kaur A, Rattan V, Rai S, Singh SP, Kalra P, Sharma S	2022	Prospective study	37 patients	19-23 y	LeFort 1 BSSO+LeFort1 (maxilla advancement) BSSO+LeFort 1	Pre-operative 6 mo post-op	DC/TMD		Reduction: . TMJ sound . TMJ pain
9	Chen CM, Chen PJ, Hsu HJ	2022	Retrospective study	60 patients (30 male, 30 female)	X m = 22.5 y X fm = 23 y	Bilateral IVRO	Pre-operative 12 mo post-op		The author just check about clicking in TMJ sound, and didn't describe about TMJ pain	Reduction: . TMJ sound (clicking only)
10	Toh AQJ, Leung YY	2022	prospective cohort study	64 patients (34 male, 30 female) (February 2019-January 2020)	18-55 y	Bilateral IVRO (62%) Bilateral SSRO (30%) IVRO+SSRO (8%).	Pre-operative Post-operative: . 3 mo . 6 mo . 12 mo	DC/TMD	The author didn't describe about TMJ sound	Stable: . TMJ pain

*BSS0 (Bilateral Sagittal Split Osteotomy; BSSRO (Bilateral Sagittal Split Ramus Osteotomy; SSRO (Sagittal Split Ramus Osteotomy; IVRO (Intraoral Vertical Ramus Osteotomy

Table 3: TMJ symptom pre and post surgery (TMJ Pain and TMJ Sound)

Author	Year	Orthognatic surgery type	Patient number	Total patient number	TMJ symptom	Pre Symptom (number/%)	Post symptom (number)
Scolozzi *et al.*	2015	LeFort 1	44	219	TMJ Pain	15	18
		BSSO	51		TMJ sound	68	63
		LeFort 1+BSSO	124				
Yoon *et al.*	2015	LeFort1+BSSRO	54	54	TMJ Pain	0	0
					TMJ Sound	10	6
Antonarakis *et al.*	2017	Lefort1	29	88	TMJ pain	5	3
		BSSO	4		TMJ sound	22	17
		Bimaxillary (LeFort 1+BSSO	55				
Zhai *et al.*	2020	Le Fort 1	66	66	TMJ pain	5	1
		BSSRO/SSRO			TMJ sound (Clicking only)	11	2
Lekroengsin *et al.*	2023	BSSRO	14	30	TMJ Pain	1	2
		BSSRO+Le Fort 1	16		TMJ sound	-	
Park *et al.*	2021	I: IVRO (deviated)+SSRO (non deviated)	8	18	TMJ pain	2	0
		II: BSSRO	10		TMJ sound	5	8
Sahu *et al.*	2022	Le Fort 1	16	56	TMJ Pain	27	6
Kaur *et al.*	2022	LeFort 1	8	37	TMJ sounds	9	6
		LeFort 1+BSSO (mandibular advancement)	10		TMJ pain	7	3
		LeFort 1+BSSO (mandibular setback)	19				
Chen *et al.*	2022	IVRO	60	60	TMJ sound (Clicking only)	26	12
Toh *et al.*	2022	IVRO	62%	64	TMJ Pain	6	6

*BSS0 (Bilateral Sagittal Split Osteotomy; BSSRO (Bilateral Sagittal Split Ramus Osteotomy; SSRO (Sagittal Split Ramus Osteotomy; IVRO (Intraoral Vertical Ramus Osteotom

Table 4: Joint pain pre and post-surgery

Joint pain			
Author, year	**Pre-operation**	**Post-operation**	**Conclusion**
Scolozzi *et al.*, 2015	15	18	Increase in Joint Pain post operation (Worsening)
Yoon *et al.*, 2015	0	0	No Change/Stable
Antonarakis *et al.*, 2017	5	3	Decrease in Joint Pain post operation (Improvement)
Zhai *et al.*, 2020	5	1	Decrease in Joint Pain post operation (Improvement)
Lekroengsin *et al.*, 2023	1	2	Increase in Joint Pain post operation (Worsening)
Park*et al.*, 2021	2	0	Decrease in Joint Pain post operation (Improvement)
Sahu *et al.*, 2022	27	6	Decrease in Joint Pain post operation (Improvement)
Kaur *et al.*, 2022	7	3	Decrease in Joint Pain post operation (Improvement)
Chen *et al.*, 2022	-	-	-
Toh *et al.*, 2022	23	10	No Change/Stable

Table 5: TMJ sound pre and post surgery

TMJ Sound			
Author, year	**Pre-operation**	**Post-operation**	**Conclusion**
Scolozzi *et al.*, 2015	68	63	Decrease in TMJ sound post operation (Improvement)
Yoon *et al.*, 2015	10	6	Decrease in TMJ sound post operation (Improvement)
Antonarakis *et al.*, 2017	22	17	Decrease in TMJ sound post operation (Improvement)
Zhai *et al.*, 2020	11	2	Decrease in TMJ sound (clicking) post-operation (Improvement)
Lekroengsin *et al.*, 2021	-	-	-
Park *et al.*, 2021	5	8	Increase in TMJ sound post operation (Worsening)
Sahu *et al.*, 2022	28	10	Decrease in TMJ sound post operation (Improvement)
Kaur *et al.*, 2022	9	6	Decrease in TMJ sound post operation (Improvement)
Chen *et al.*, 2022	26	12	Decrease in TMJ sound post operation (Improvement)
Toh *et al.*, 2022	-	-	-

-TMJ Sound

A worsening of TMJ symptoms (TMJ sound) after surgery, including increased pain and dysfunction of the temporomandibular joint, was found in one study [9], with deterioration typically associated with biomechanical factors or post-surgical mismatches, such as drastic changes in occlusion (table 5) [13].

No change/Stable

-TMJ Pain

Studies [9, 13] showed no significant change or stability in TMJ conditions (TMJ pain) before and after surgery. The patients in this category did not experience any decrease or increase in symptoms from pre-to post-surgical assessment." (table 4) [10, 18]

-TMJ Sound

No studies showed no significant change/stable in TMJ conditions (TMJ sound) from pre and post-surgery. The number of patients in this category did not experience any decrease or increase in symptoms before and after the surgical procedure (table 5).

DISCUSSION

The primary focus of this study was to assess temporomandibular joint (TMJ) pain dan sound (crepitus, clicking, and popping) before

and after undergoing orthognathic surgery. Authors analyzing 10 publications during review the scientific literature. All the publications examined individuals with dentofacial deformities who were candidates for orthognathic surgery. Orthognathic surgery is a standard treatment for patients with dentofacial deformities. It involves repositioning the upper jaw (maxilla) and/or lower jaw (mandible) to improve their alignment, helping to restore balance and achieve both dental and skeletal harmony. This procedure can enhance chewing function and facial aesthetics for the patient [20, 21]. The impact of orthognathic surgery on the temporomandibular joint (TMJ) is a critical consideration in maxillofacial procedures [21, 22]. The temporomandibular joint (TMJ) may undergo degenerative deformation as a response to orthognathic surgery. In such cases, the entire condyle experiences remodeling, a reduction in ramus height occurs, mandibular growth is inhibited, and the position of the supramental point shifts [23]. Several factors contribute to condylar displacement during orthognathic surgery, including the supine position of the patient under general anesthesia, the method of osteotomy fragment fixation, surgical technique, bony interference between proximal and distal segments, accurate manipulation of the proximal segment during fixation, and changes in the occlusal plane [24].

Identifying the position of the condyle and the relationship between the disk and condyle is essential in orthognathic surgery to avoid potential TMJ issues, which could ultimately result in skeletal relapse [25–27]. From this systematic literature review, there are 6 from 10 studies that show improvement in TMJ pain after the surgery. There are just 2 studies that show worsening in Joint Pain after the surgery, and 1 studies shows stable conditions before and after the surgery. There are 7 from 10 studies that show improvement in TMJ sound after the surgery. There are just 1 studies that show worsening in Joint Sound after the surgery. Orthognathic surgery changes the patient's occlusion and neuromuscular system, requiring time for the body to adjust. Following surgery, changes in joint positioning trigger adaptive responses in the surrounding ligaments and muscles. As noted by Lindemeyer *et al.* [28], orthognathic surgery impacts both the hard and soft tissues of the maxillofacial region, which in turn affects the TMJ. orthognathic surgery impacts both the hard and soft tissues of the maxillofacial region, which in turn affects the TMJ According to Nakata *et al.*, [29] the physiological adaptation of the affected structures typically takes more than two years to complete. Different outcomes were observed when evaluating joint pain, although most studies reported a reduction in the number of patients experiencing these symptoms during various postoperative periods.

The reduction in joint dysfunction complaints can be attributed to several factors. Firstly, there is an improvement in neuromuscular coordination, which leads to reduced functional interference between the temporomandibular joint (TMJ), muscles, and occlusion. Additionally, harmful loading on the stomatognathic system is reduced due to decreased parafunctional activities. Degenerative changes in the TMJ are also minimized, thanks to the reduction in inflammation of the synovium and articular disc. Furthermore, the relationship between the condyle and articular disc improves, contributing to better joint function. Patients also experience better psychological well-being, which is linked to improved masticatory function and aesthetics. Finally, enhanced intercuspation after surgery plays a role in alleviating dysfunction [16].

In this review, two studies reported worsening of joint pain, and one study observed a worsening of TMJ sounds following orthognathic surgery. For patients undergoing such procedures, it is recommended to perform Virtual Surgical Planning (VSP) preoperatively, as it has been shown to result in smaller condylar positional changes. This approach helps preserve the anatomical relationship of the temporomandibular joint during mandibular osteotomy procedures [30]. In addition, adjunctive therapy using stabilization splints may be considered, as these splints offer a high level of precision. Using stabilization splints during surgery when appropriate; applying suitable rigid fixation techniques; addressing maxillary bone defects by grafting with either bone or synthetic materials to improve stability and promote healing; [31–33] ensuring optimal occlusal interdigitation during surgery; and surgically correcting any temporomandibular joint (TMJ) issues. Along with poor surgical technique and inadequate fixation, failure to properly identify and treat TMJ pathologies is one of the most common reasons for relapse and failure following orthognathic surgery [34, 35]. The combination of splint fabrication with CAD/CAM technology has emerged as the preferred approach, due to its superior accuracy, enhanced predictability, and expedited fabrication process [36].

The varying impacts of orthognathic surgery on the temporomandibular joint system can be attributed to several factors, including the duration of postoperative follow-up, the preoperative alignment of the patient's jaws, the surgical technique used, the surgeon's expertise, the approach to postoperative intermaxillary fixation, as well as the methods and criteria applied to assess arthralgia, among others [18]. In this review, the majority of the studies highlight significant improvements in temporomandibular joint (TMJ) conditions, including both pain and dysfunction. These positive outcomes are influenced by a variety of factors: performing precise and accurate surgery; segmenting the maxilla when necessary to enhance stability of the outcome [37]. The variability in outcome measures, particularly the inconsistent use of standardized diagnostic tools like RDC/TMD-limits the comparability of the included studies. Future research would benefit from the adoption of uniform assessment criteria to allow for more robust comparisons and meta-analytical synthesis.

Future studies are recommended to include long-term follow-up periods (>5 y) in patients undergoing orthognathic surgery with various surgical techniques (such as BSSRO, IVRO, and Le Fort I), particularly to monitor changes in temporomandibular joint (TMJ) function and the emergence or recurrence of clinical symptoms postoperatively. Additionally, further research is needed to stratify and compare different orthognathic surgical approaches in relation to TMJ outcomes.

CONCLUSION

Orthognathic surgery typically enhances TMJ conditions, although there are instances where it may aggravate the problem. Thorough pre-surgical planning and careful patient selection are crucial for achieving the best results and minimizing the risk of worsening TMJ. More research is needed to gain a deeper understanding of the factors that affect surgical outcomes

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CONFLICTS OF INTERESTS

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