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Relapse and temporomandibular joint dysfunction (TMD) as postoperative complication in skeletal class III patients undergoing bimaxillary orthognathic surgery: A systematic review

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ABSTRACT

Objectives: The aim of this study was to determine Relapse and TMD as postoperative complication in skeletal class III patients undergoing bimaxillary orthognathic surgery.

Materials and methods: Data was obtained by database searching using The Cochrane Central Register of Controlled Trials (central), PUBMED, SCOPUS, EMBASE, Google scholar, National Medical library, New Delhi. The titles and abstracts of the electronic search results were screened and evaluated by two observers for eligibility according to the inclusion and exclusion criteria.

Results: 5261 articles were retrieved for the review. Among these, 3474 duplicate articles were removed. 418 studies were selected based on the eligibility criteria. For the present review, 30 articles were included after elimination according to the inclusion criteria. The Prisma diagram flowchart demonstrates our selection scheme. Quality assessment criteria to evaluate the studies were decided by two review authors in accordance with CONSORT guidelines. Each study was assessed using the evaluation method described in the Cochrane Handbook for Systematic Reviews. Among the 30 studies included in the review, marked degree of relapse in the mandible was noted from 3 months - 1 year postoperatively in 8 studies, 5 studies reported both TMD prevalence and relapse, whereas only 4 studies reported TMD disorder alone.

Conclusion: Complications of relapse and TMD are associated with bimaxillary orthognathic surgery procedures. More RCTs and CCTs are needed in this regard to get better quality evidence. This review was registered with PROSPERO: CRD42020211342.

1. Introduction

Orthognathic surgery is frequently performed by oral surgeons for treatment of maxillofacial deformities. The surgery has psychological and social benefits, as it causes improvement in the function and facial appearance of the patient. Achievement of long-term stability after surgical correction is essential for the success of the procedure.[1]

However, complications do occur while performing orthognathic surgery such as relapse (change in position of bones after surgery), maxillary sinusitis, sensory nerve morbidity, bone necrosis, loss of tooth vitality, vascular complications, unfavourable fractures of the skull base or pterygoid plates, nasal septum deviation, malpositioning, nonunion, and temporomandibular joint (TMJ) problems, A combination of complications are rare but could be fatal. The surgeon does keep an account of preventive protocols and is also prepared to treat them if they occur.[2–5]

Bimaxillary surgery is planned when both jaw osteotomized after the consensus diagnostic planning and evaluation.[6] Bimaxillary surgeries have been practiced for many years now, with the advantages of enhancing the aesthetic profile of the patient and rendering the functional correction with reduction in morbidity and mortality.[6]

Although systematic reviews have investigated orthognathic surgeries in terms of preoperative, intraoperative and postoperative complications, antibiotic prophylaxis and skeletal stability,[6–8] none have examined the incidence of relapse and temporomandibular joint

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dysfunction (TMD) as postoperative complications in skeletal Class III patients treated with bimaxillary orthognathic surgery. There is lack of clear evidence regarding the same in literature.

Consequently, the aim of this systematic review was to assess relapse and TMD as postoperative complications after bimaxillary orthognathic surgery for skeletal class III patients.

2. Material and methods

The PICOS (participants, intervention, comparisons, outcomes, and study design) criteria was focused on skeletal Class III patients, having age 14 years or above, had undergone bimaxillary orthographic surgery. Outcomes assessed were: post-operative complications of relapse and TMD. Regarding the study design, this review included studies from January 1980 to August 2020 concerning population of all groups. It included all randomized trials, observational studies and case reports conducted and reporting complications of either relapse or TMD or both. Uncontrolled trials or non-randomized trials, split-mouth trials were also included in this review. Abstracts, editorials, review articles, animal studies, in vitro studies, split-mouth studies, studies irrelevant to orthognathic surgery and studies other than English language were excluded from this study.

An electronic search of PubMed, The Cochrane Central Register of Controlled Trials (CENTRAL), EMBASE, SCOPUS, Google Scholar, and National Medical Library, New Delhi databases was executed from January 1980 to August 2020. The search strategy includes 2 aspects: presence of Relapse and/or TMD and any other postoperative complication encountered in patients having skeletal Class III profile treated by bimaxillary orthognathic surgery in relation with etiology i.e. craniofacial syndromic or skeletal class III patients. The bibliographies of identified RCTs, review articles and relevant systematic reviews were cross checked for extra investigations. The Clinical Trial Registry of India (CTRI) was looked at in August 2020 for ongoing studies. The relevant journals present in the institutional library were identified and hand searched for this review.

Two review authors (Neeraj, Gosla Reddy S) independently examined the title, keywords and abstract of papers after searching through electronic searching for proof of eligibility criteria. The keywords used were "COMPLICATION AND ORTHOGNATHIC AND/OR SURGERY", "COMPLICATION AND BIMAXILLARY AND/OR SURGERY", "TMD AND BIMAXILLARY AND/OR SURGERY", "TMD AND ORTHOGNATHIC AND/OR SURGERY", "RELAPSE AND BIMAXILLARY AND SURGERY", "RELAPSE AND BIMAXILLARY ORTHOGNATHIC AND/OR SURGERY", "STABILITY AND ORTHOGNATHIC AND/OR SURGERY", "STABILITY AND BIMAXILLARY AND/OR SURGERY", "CONDYLE AND BIMAXILLARY AND SURGERY", "SKELETAL CLASS III AND BIMAXILLARY AND SURGERY", "SKELETAL CLASS III AND/OR BIMAXILLARY ORTHOGNATHIC AND/OR SURGERY".

The trials, observation studies, case reports that seemed to meet the inclusion criteria, or those for which data in the title and abstract was

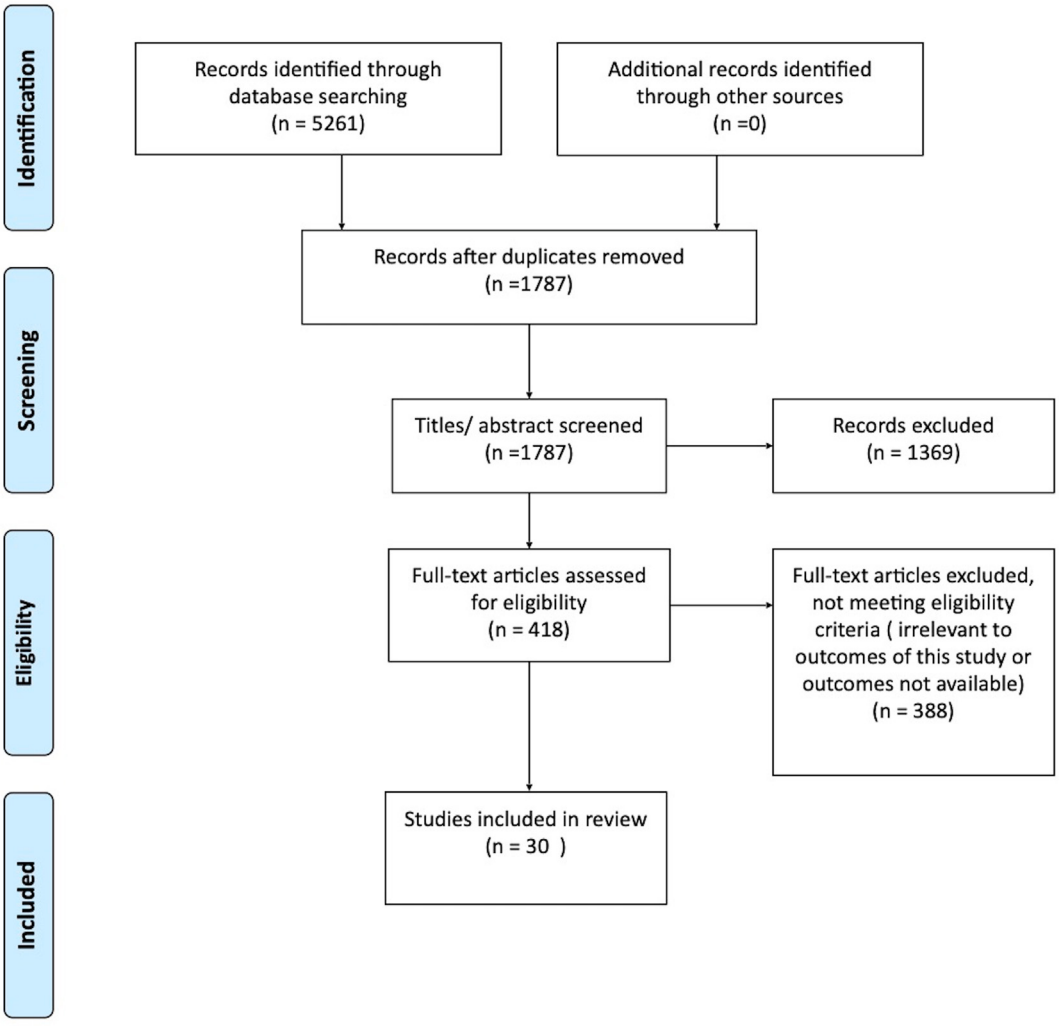

Fig. 1. PRISMA flow diagram.

inadequate to allow clear choice, were explored in the wake of getting their full report. Differences were settled by discussion by two other authors. Articles only in the English language were included.

The protocol was registered with PROSPERO: CRD42020211342.

3. Results

The electronic search produced a total of 5261 articles for the review. From them, 3474 duplicate articles were removed. Abstracts of all the articles were reviewed independently. A total of 1369 articles excluded following scrutiny of abstracts. Full text articles retrieved for 418 and after reviewing these articles independently, 388 articles were further excluded. After scrutinizing as per eligibility criteria, 30 articles were included for the present review.

The PRISMA flow diagram (Fig. 1) gives a summery of this selection process. Table 1 gives summary of the selected sample's type of study, year of publication, author, patients included, intervention and comparison, time duration, primary and secondary outcome.

3.1. Quality assessment[39]

According to the guidelines, two review authors (Neeraj, Gosla Reddy S) evaluate the studies using quality assessment criteria, as described in the Cochrane Handbook for Systematic Reviews. Thirty of the included studies were RCTs, Quasi experimental or comparative cross sectional studies. Two reviewers independently undertook the quality assessment of the included trials. The domains evaluated were study design, randomisation method, method of outcome measurement and risk of bias. The 5 RCT (Landes CA et al.,[13], Tuovinen V et al.,[17] Pereira-Filho VA et al.,[18] Park SB et al.,[19] Rossi D et al.[28]) were assessed using Cochrane tool for Risk of Bias (RoB version 5.1/5.2) in which six domains were assessed. These were all assessed overall as having high risk of bias (Fig. 2).

The remaining studies were retrospective in nature or case control studies and were classified as 'fair' using Newcastle Ottawa Scale. In general, both quality and level of evidence of the investigated articles were limited.

McCance AM et al.(1992)[9] reported marked level of relapse by laser scanning in the mandible due to the anterior movement of maxilla from 3 months to 1 year postoperatively. Hoppenreijs TJ et al.(1999),[11] assessed 26 patients after bimaxillary osteotomy (n = 7) and bilateral sagittal split advancement osteotomy (n = 19); and reported 7 of them having satisfactory occlusal and aesthetic results. Four patients with a stable occlusion had 40–80% relapse. Landes CA et al.(2006)[13] assessed, thirty patients using lateral cephalograms and reported resorbable materials showed slight clinical mobility up to 6 months post operatively permitted clinically faster occlusal and condylar settling as compared to titanium osteosynthesis. In a study by Kretschmer WB et al.(2019)[33]Condylar resorption was found in 29 patients (5.8%), with only 14 patients had symptoms in the temporomandibular joint related symptoms out of 500 bimaxillary orthognathic patients assessed. Takahara N et al.(2020)[37] assessed 50 patients and reported mean relapse of 0.95 mm (11.6%) 1 year postoperatively.

4. Statistical analysis

No meta-analysis was carried out due to the heterogeneity between the studies.

5. Discussion

Bimaxillary osteotomy is a routine procedure performed for the rectification of craniofacial deformities. Being an accepted invasive procedure for correcting dentofacial deformities, the precision of treatment planning and surgical technique is very essential for the optimal functional as well as aesthetic outcome as well as to avoid complications. But till date, this relatively simple technique remains misunderstood and misused. The decision to perform two jaw surgery should take into consideration the patient's chief complaint, objective assessment of the patient's facial profile, the amount of skeletal discrepancy, and the factors contributing towards stability. These procedures should be done on day-to-day basis with minor discomfort, complications and postsurgical hospitalization.The movement of skeletal structures leads to a change in the soft tissues with a significant effect on the facial aesthetics.[1] Despite great clinical success reported across literature, a variety of complications are associated with this procedure. Complications are: early (complications during surgery) and late (postoperative complications). Intra-operative complications include haemorrhage, soft tissue injury, delay in wound healing and bad splits. Postoperative complications include TMD, skeletal relapse and prolonged sensory impairment.[40–42]

The major concern is the postsurgical stability after orthognathic surgery. Postoperative instability (relapse) both early or late onset has been shown to hinder the obtainment of adequate long-term results. One of the reason is suboptimal condylar seating or slippage at osteotomy site which occurs within 6 months postoperatively leading early skeletal relapse.[43,44] Approximately 6–12 months after surgery late relapse tends to occur. The pathophysiology of delayed skeletal relapse contrasts from the acute setting, because of certain patient characteristics, for example condylar resorption and type and magnitude of the surgical displacement.[45,46] This Postoperative position is governed by several factors like tensional balance of surrounding soft tissue and muscles, method of fixation, distal segment's rotational movement, and surgeon's experience.

Often a gaps is created between bony (proximal and distal) segments after surgery Bony interference between bony segments may be causally related to relapse. This can be avoided by introducing the Bend over the distal segment posterior to the last molar, performing a bone graft in the area of the segment gap, and bending plate fixation. Often physiological equilibrium of the pterygomasseteric sling gets disrupted, which subsequently affect the functioning of the muscles of mastication. These changes in the muscles often cause rotation of the proximal segment counterclockwise to set it back to its original position. Angle ostectomy might affect the length of the pterygomasseteric sling, thereby reducing the pterygomasseteric tension and lowering the rate of relapse after surgery.[48,49]

Superior repositioning of the posterior maxilla and mandibular angle resection can minimize the occurrence of relapse following a mandibular setback surgery.

Occlusion may differ from that anticipated in the treatment plan after orthognathic surgery. Preoperative and postoperative orthodontics can accomplish good occlusion, as it provides a stable anatomical relation mostly affected by the dentoalveolar architecture, articulation of the TMJ as well as the masticatory muscles. This dynamic relation is subject to variation and does influence proprioception, neuromuscular function, level of consciousness and gravity. The occlusion may relapse as a result of changes in the condylar position immediately, positional assessment of temporomandibular joint (TMJ) after orthognathic surgery is vital for predictable treatment outcome and maximising stability. Assessment of the occlusion as well as understanding of the changes in occlusion that are secondary to the displacement of condyle can reliably recognised during the operation.[5–7] Temporomandibular joint (TMJ) without a doubt impacted by the impact of gravity as well as by the anatomical structure of the TMJ and the level of operative displacement.[47]

Among 30 studies included in the review, from 3 months to 1 year marked relapse was found in the mandible postoperatively and was reported among 8 studies, 5 studies reported both TMD prevalence and relapse, whereas only 4 studies reported TMD disorder. The study of Rossi D et al. (2018)[28], Liu H et al. (2017)[26] and Hemmatpour S et al.(2016)[25] did not report complications. Toro C et al. (2007)[15], Moure C et al. (2012)[20], Kor HS et al. (2014)[22], Cullati F et al. (2019),[29] Han JJ et al. (2019)[32], Kim JW et al. (2019)[34] and Stokbro K et al. (2020)[36] reported no relapse in the follow up period in their respective studies. Among these, only the study by Maurer P et al. (2001)[12] reported

Table 1
Summary of the sample's year of publication, author, study design, patients included, intervention and comparison, time duration, primary and secondary outcome.

AUTHOR (YEAR)	STUDY DESIGN	PATIENTS	INTERVENTION	COMPARISON	TIME DURATION	PRIMARY OUTCOME	SECONDARY OUTCOME
McCance AM et al. (1992)[9]	Observational	16 skeletal Class III adult patients	Bimaxillary orthognathic surgery	Control group of 30 male and 30 female, with a class I skeletal relationship and average facial heights	3 months to one year	Relapse: Nasal tip – 5 mm Maxilla −3 mm. Chin- 5 mm and angles of the mouth. Body regions −3 mm (bilaterally)	NOT REPORTED
Sanromán JF et al. (1997)[10]	Analytical cross sectional	24 patients with class III dentofacial deformity	9 had isolated maxillary osteotomies and 15 had combined maxillary and mandibular subcondylar osteotomies (MSO)	Control group of 10 without dentofacial deformity, with normal clinical TMJ examination	Not mentioned	No relapse No prevalance of TMD	–
Hoppenreijs TJ et al. (1999)[11]	Observational	26 patients who developed progressive condylar resorption (PCR) following a bilateral sagittal split advancement osteotomy (n = 19) or a bimaxillary osteotomy (n = 7).	Bimaxillary orthognathic surgery	–	Not mentioned	Relapse: 30%- 1 patient 40-80%- 4 patients 100%- 2 patients 120%- 1 patient	NOT REPORTED
Maurer P et al. (2001)[12]	Observational	507 patients	Bilateral sagittal split osteotomy (n = 336, 66%), Le Fort I osteotomy (n = 29, 5.9%), bimaxillary osteotomy (n = 35, 6.3%), and segment osteotomy (n = 107, 21.1%).	–	One year follow up	No relapse No prevalance of TMD	Neurosensory deficit of the inferior alveolar nerve Inflammatory wound
Landes CA et al. (2006)[13]	Randomized controlled trial	30 patients underwent osteofixation with poly(L-lactide-*co*-DLlactide) copolymer and 30 had 2.0-mm titanium-miniplate osteosyntheses.	Bimaxillary orthognathic surgery	–	One year follow up	Relapse: After 1 year, Study group- 3 patients: partial clinical relapses with lateral end to-end bite. Control group- 4 patients: partial clinical relapses	Not reported
Chow LK et al. (2007)[14]	Observational	A total of 2910 orthognathic procedures were performed on 1294 consecutive patients in the 15-year period	1070 patients undergoing bimaxillary procedures	224 patients undergoing single-jaw surgery	–	No relapse No prevalance of TMD	Post-operative infection Re-operation/ replating
Toro C et al. (2007)[15]	Analytical cross sectional	Patients with maxillary hypoplasia and mandibular hyperplasia who had been listed for bimaxillary operations.	study group (n = 78), 45 women and 33 men, age range 18–45 years (mean 24).	control group (n = 74), 39 women and 35 men, age range 18–33 years (mean 23).	12-month follow-up	No relapse No prevalance of TMD	–
Iannetti G et al. (2007)[16]	Analytical cross sectional	40 patients with class III malocclusion and anterior open bite is evaluated.	Group B (n = 20) treated with bimaxillary surgery	Group A (n = 20) underwent only Le Fort I osteotomy	–	Relapse: In all patients- 2° decrease of the gonial angle from T1 to T2. A mandibular relapse of 0.4- and 0.727-, respectively, in group B1 and B2 was observed 2 years after surgery.	–
Tuovinen V et al. (2010)[17]	Randomized controlled trial	101 patients with 192 osteotomies	Orthognathic surgery was performed on 101 patients	Bilateralsagittal ramus osteotomy was performed on 55 patients using bioabsorbable osteosynthesis in 26 and titanium osteosynthesis in 29 patients	–	Relapse: A clear relapse tendency in skeletal measurements was seen in all groups. The fixation material did not seem to have an effect on the skeletal relapse but have an impact on overbite in the maxillary operation group, indicating dental relapse	–
Pereira-Filho VA et al. (2011)[18]	Randomized controlled trial	45 patients with skeletal Class III/ cephalometric evaluation of	The subjects were divided into 3 groups: group 1 underwent	group 2 underwent maxillary advancement surgery (15	–	No complication reported	–

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Table 1 (*continued*)

AUTHOR (YEAR)	STUDY DESIGN	PATIENTS	INTERVENTION	COMPARISON	TIME DURATION	PRIMARY OUTCOME	SECONDARY OUTCOME
		deformity was performed.	bimaxillary surgery (23 patients),	patients), and group 3 underwent mandibular setback surgery (7 patients).			
Park SB et al. (2012)[19]	Randomized controlled trial	36 Class III patients undergone bimaxillary surgery or isolated mandibular setback	Group A (20 patients) had undergone mandibular setback sagittal split ramus osteotomy (SSRO with rigid fixation)	Group B (16 patients), LeFort I osteotomy with advancement and mandibular setback SSR	–	Relapse: In group A, the anteroposterior length (APL) on the CV2 and CV4 planes was significantly correlated with the mandible relapse. In group B, the cross sectional area (CSA) on axial plane on the PNS– Vp plane was significantly correlated with the maxilla relapse ($p < 0.05$)	–
Moure C et al. (2012)[20]	Observational	30 consecutive cases of bimaxillary orthognathic surgery with biodegradable self-reinforced poly-L/DL-lactide plates and tacks, for the same indication of Angle class III malocclusion	Bimaxillary orthognathic surgery	–	–	No complication reported	–
de Haan IF et al. (2013)[21]	Observational	A total of 30 patients who had undergone orthodontic treatment combined with orthognathic surgery were included	Bimaxillary orthognathic surgery	–	–	Relapse: More than >2 mm or 2°) relapse Bimaxillary procedures-24%, Mandibular setback −21%, Upper-jaw surgery-21%, Lower-jaw surgery-27%.	–
Kor HS et al. (2014)[22]	Analytical cross sectional	Patients (n = 29) were divided into two groups according to the change of mandibular occlusal plane angle (MnOP)	Bimaxillary orthognathic surgery	–	one year follow uP	No relapse	occlusal stability
Scolozzi P et al. (2015)[23]	Retrospective cohort study	219 patients (210 Caucasians, 5 Africans, and 4 Asians). The mean age was 24.9 years (range 15–56 years)	Bimaxillary orthognathic surgery	–	–	Prevalance of TMD: Among 127 patients, 28 (22%) without disk displacement developed TMD after surgery.	–
Posnick JC et al. (2016)[24]	Cohort	Two hundred sixty-two treated by a single surgeon between 2004 and 2013 was studied	Bimaxillary orthognathic surgery	–	–	Relapse Was not seen	no occurrences of wound infection, fibrous union, or aseptic necrosis
Hemmatpour S et al. (2016)[25]	Quasi experimental	20 skeletal Class III Iranian patients needing bimaxillary Le Fort I osteotomy plus mandibular setback surgery	Bimaxillary orthognathic surgery	–	–	No complication reported	–
Liu H et al. (2017)[26]	Case series	12 hemifacial microsomia patients treated with bimaxillary DO and secondary orthognathic surgery between 2006 and 2013 were included	Bimaxillary orthognathic surgery	–	–	Prevalance of TMD: 4 cases showed mild pain in the temporomandibular joint area on the affected side during the distraction period	lower lip paresis
AlWarawreh AM et al. (2018)[27]	Quasi experimental	100 consecutive patients with craniofacial deformities (31 male and 69 female), age range between 17 and 58 years (mean age: 27.7 ± 9.3 years).	Bimaxillary orthognathic surgery	–	–	Prevalence of TMD: postoperatively 27% reported TMD, 12 patients developed clicking in TMJ after surgery, 3 developed pain, and 3 developed crepitus.	–
Rossi D et al. (2018)[28]	Randomized controlled trial	25 patients with WARNING!!! TEXT	11 patients, osteotomies were made using conventional saw	piezoelectric device was used.	–	No complication reported	–

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Table 1 (*continued*)

AUTHOR (YEAR)	STUDY DESIGN	PATIENTS	INTERVENTION	COMPARISON	TIME DURATION	PRIMARY OUTCOME	SECONDARY OUTCOME
		MISMATCH WITH THE INTERREF. PLEASE CHECK					
		dentofacial de formities (7 male and 18 female), treated from January 2016 to September 2017					
Cullati F et al. (2019)[29]	Observational	15 patients with dentoskeletal class III facial dysmorphism (7 men, 8 women, mean age 28 years).	bimaxillary orthognathic surgery	–	–	No complication	–
Kantar RS et al. (2019)[30]	Observational	3 groups of interest included	bimaxillary osteotomies (n = 190).	mandibular osteotomies (n = 126) LeFort I osteotomy (n = 194),	–	No complication	• Wound complications, Re-operations
Song IS et al. (2019)[31]	Observational	378 participant	bimaxillary orthognathic surgery with adjunctive procedures	bimaxillary orthognathic without adjunctive procedures	–	No complication	nasal congestion swelling pain breathing difficulty
Han JJ et al. (2019)[32]	Retrospective cohort study	30 patients Surgical and postoperative changes evaluated using lateral cephalograms taken 1 month before surgery (T0), 1 week after surgery (T1), and immediately after debonding of orthodontic appliances (T2; 16.6 ± 8.7 months after surgery).	14 patients (BMS group; mean age, 19.9 years; range, 17–26 years) underwent mandibular setback surgery combined with Le Fort I osteotomy	16 patients (IMS group; mean age, 22.2 years; range, 18–29 years) underwent an isolated mandibular setback surgery	–	Relapse: IMS and BMS groups exhibited additional postoperative horizontal relapse by 0.7 mm and 0.5 mm, respectively, corresponding to 8.2 and 4.3% of the mandibular setback movement	–
Kretschmer WB et al. (2019)[33]	Observational	500 patients with different craniofacial deformities	Bimaxillary orthognathic surgery	–	one year follow up	Prevalance of TMD post operatively: pain - 6.4% patients, clicking- 19.1% patients, crepitus- 4.8% patients who had none preoperatively	–
Kim JW et al. (2019)[34]	Observational	Thirteen patients who underwent OGS from 2015 to 2017 were included	Bimaxillary orthognathic surgery	–	one year follow up	No relapse	–
Liebregts J et al. (2019)[35]	Observational	106 patients had an individualized 3D virtual operation plans, received either maxilla-first (n = 53) or mandible-first (n = 53) surgery.	Bimaxillary orthognathic surgery	–	–	Relapse - maxilla-first surgical approach,(cranial: 0.7 ± 1.1 mm, $p < 0.01$; caudal: 0.7 ± 1.4 mm, $p < 0.01$). For mandible, only the posterior (1.8 ± 1.2 mm, $p < 0.01$) and caudal (1.4 ± 2.0 mm, $p < 0.01$) translations displayed relapses greater than 1 mm. For the rotational movements in maxilla, pitch clockwise(CW) −1.0° ± 1.3°, $p < 0.01$; counterclockwise(CCW) −0.9° ± 1.6°, $p < 0.01$). In the mandible, pitch(CW 0.8° ± 1.9°, $p = 0.02$; CCW 2.3° ± 2.6°, $p < 0.01$).	–
Stokbro K et al. (2020)[36]	Retrospective cohort	17 patients included (mean age, 28 years; female gender, 35%; bimaxillary surgery, 59%).	Bimaxillary orthognathic surgery	–	One year follow up	Relapse: Only 1 patient experienced a skeletal relapse of more than 1 mm in the posterior direction	–
Takahara N et al. (2020)[37]	Case series	19 men and 31 women (mean age 23.1 years)	Bimaxillary orthognathic surgery	–	–	Relapse: The anterior changes at point B were 0.57 mm (6.9%) at 6 months after surgery and 0.95 mm (11.6%) at 1 year after surgery.	–

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Table 1 (*continued*)

AUTHOR (YEAR)	STUDY DESIGN	PATIENTS	INTERVENTION	COMPARISON	TIME DURATION	PRIMARY OUTCOME	SECONDARY OUTCOME
						Horizontal relapse of the mandible 1 year postoperatively was significantly negatively correlated with the amount of surgical repositioning	
Cao J et al. (2020)[38]	Observational	56 patients with unilateral mandibular condylar OC combined with secondary facial asymmetry and malocclusion	Bimaxillary orthognathic surgery	–	12–18 months follow-up.	No relapse No prevalance of TMD.	–

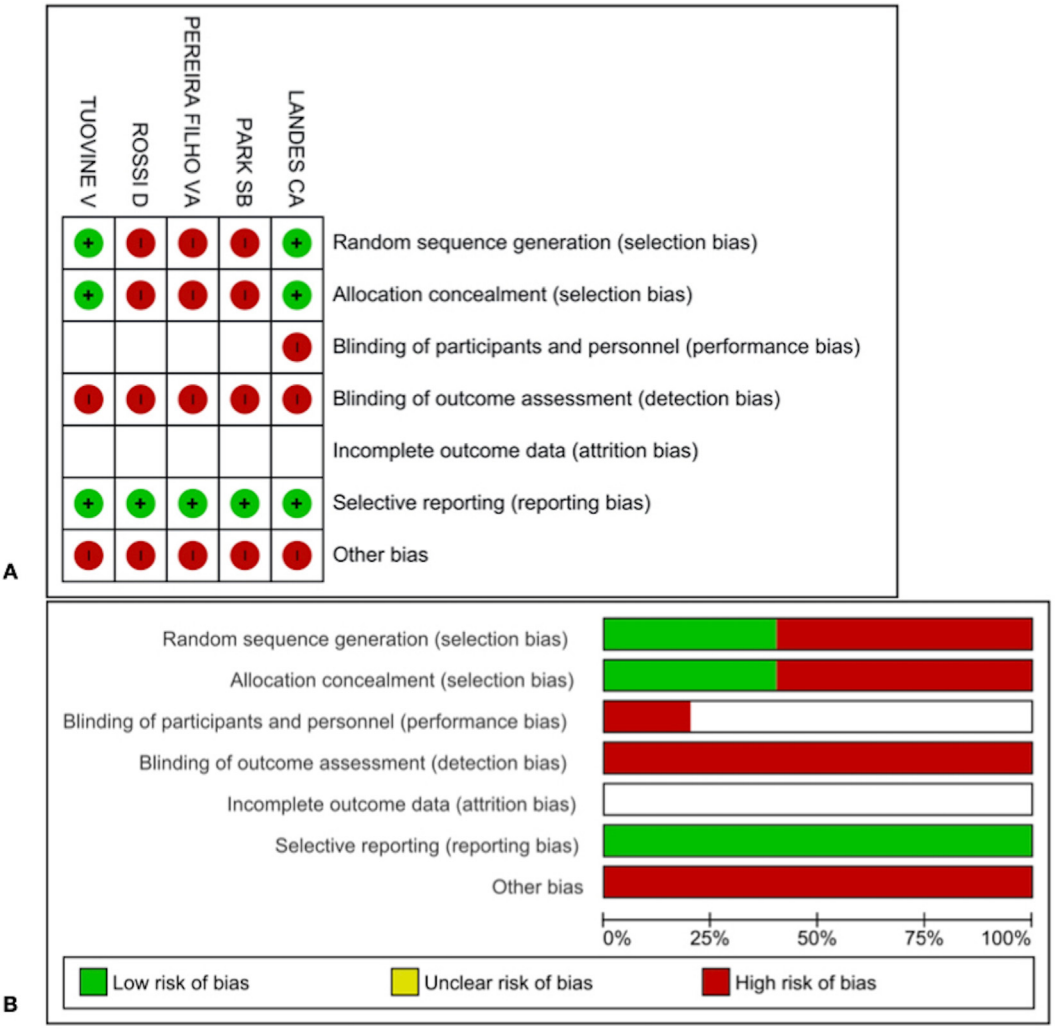

Fig. 2. Assessment of risk of bias.**A** Summary of risk of bias for each randomized trial assessed by Cochrane Collaboration's tool. **B** Risk of bias graph about each risk of bias item presented as percentage across all included randomized trials.

postoperative neurosensory deficit of the inferior alveolar nerve after a year and inflammatory wound healing. Posnick JC (2016)[24] mentioned that there were no event of fibrous union, aseptic necrosis in the maxillary region, wound infection in any subjects yet 2 patients sustained a persistent oronasal fistula. Kantar RS et al. (2019)[30] reported wound complications, reoperations and readmissions among their patients. Song IS et al. (2019)[31] reported swelling, pain and breathing difficulty following nasal congestion.

Number of retrospective studies have reported low rate of complications following orthognathic surgeries. However, many perioperative variables are linked to cause increased risk of complications.[16–35]

The studies included in the review has employed a wide range of methods to assess the degree of replase such as Laser scanning, cephalometrics and cone-beam computed tomography (CBCT) scan. TMJ evaluation was done using functional analysis index (Helkimo, 1974) modified by Athanasiou et al. (1989).

Skeletal stability assessment of patients treated with orthognathic procedure is fraught with problems related to the inter-observer differences in the localization and interpretation of landmarks as well as need of acquiring a homogenous sample of patients. Depending on the amount of surgical alteration of the mandibular position, patients show a moderate rate of mandibular relapse. Orthognathic surgery does have possible onset of TMD disorders in patients without preoperative problems although TMD problems can occur in various patients, undergoing orthognathic surgery. The prevalence of other complications like neurosensory deficit, paraestheia or infection do occur but their reporting is relatively low in existing literature. The second most commonly encountered complication of bimaxillary orthognathic surgery is temporomandibular joint (TMJ) disorders. The other complications reported include reoperation, infection, necrosis, parasthesia, neurosensory deficit.

Controversy surround the TMDs. The researchers suggest that all types of orthognathic surgery can directly or indirectly affect temporomandibular joint symptoms. Henceforth, their diagnosis prior to surgery and treatment planning regarding the same should be done. For this a standard index should be developed. Sagittal split ramus osteotomy: SSRO and Intra oral ramus osteotomy: IVRO for posterior displacement of the mandible can be applied to all patients with TMD. All bony interferences that exist should be removed. Condylar heads should be passively settled into the glenoid fossa during surgery. Non-rigid fixation using monocortical plates and screws can be done. Use of compression plates or lag screws should be avoided. In double jaw surgeries, it may be more advantageous to start operating on the mandible first.[47,48]

In conclusion, a wide variety of complications are associated with bijaw orthognathic surgery, that are sometimes hard to predict. A clear distinction needs to be made between malpractice and complications by Oral and maxillofacial surgeons. Relapse and TMD are the ones, most commonly associated with bimaxillary orthognathic surgery, and the surgeons are require to inform the patients as well as try to minimize the rate of these complications. During our research the studies reporting complications that we encountered were majorly case series, case reports or reviews. These studies do not report long term postoperative complications and do not provide reliable evidence. Additionally, the critical appraisal of all included RCTs and CCTs were assessed as to having a high risk of bias. Therefore s, more great quality RCTs and CCTs are required on this point to give better evidence.

5.1. Limitations of the study

This systematic review has few limitations. Age or gender related rates of relapse or TMD were not assessed. The complications under study after bimaxillary orthognathic surgery were not evaluated in comparison to other treatment modalities like single jaw procedures. The different techniques used to measure relapse were also not compared.

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Declaration of competing interest

The authors declare there is no conflict of interest.

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