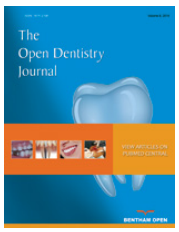

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Supplementary Material

Latest Evidence on Orthognathic Surgery Techniques and Potential Changes in Oral Microbiota related to Intermaxillary Fixation in Orthodontic Patients: A Systematic Review

Matteo Pellegrini[1,2], Maria Gloria Nardi[3], Federica Pulicari[1,2], Andrea Scribante[3,*], Umberto Garagiola[1,2] and Francesco Spadari[1,2]

[1]*Maxillofacial Surgery and Dental Unit, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, 20122 Milan, Italy*
[2]*Department of Biomedical, Surgical and Dental Sciences, University of Milan, Via della Commenda 10, 20122Milan, Italy*
[3]*Unit of Orthodontics and Pediatric Dentistry, Section of Dentistry, Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy*

Table S1. PRISMA 2020 checklist.

Section and Topic	Item #	Checklist Item	Location where Item is Reported
TITLE			
Title	1	Identify the report as a systematic review.	Title
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Initial introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	End of introduction
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Dedicated section in M&M
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Dedicated section in M&M
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Dedicated table
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Dedicated section in M&M
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Dedicated section in M&M
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (*e.g.* for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Dedicated section in M&M
	10b	List and define all other variables for which data were sought (*e.g.* participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Dedicated section in M&M

(Table 1) contd.....

Section and Topic	Item #	Checklist Item	Location where Item is Reported
TITLE			
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	2 reviewers assessed the risk of bias – specified in M&M
Effect measures	12	Specify for each outcome the effect measure(s) (*e.g.* risk ratio, mean difference) used in the synthesis or presentation of results.	Mean difference (M&M)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (*e.g.* tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Type of intervention
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Procedure described M&M
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Procedure described M&M
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Answer to PICO
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (*e.g.* subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Reported conclusions of the included RCT
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Dedicated table
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Dedicated table
Study characteristics	17	Cite each included study and present its characteristics.	Dedicated table
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Dedicated table
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (*e.g.* confidence/credible interval), ideally using structured tables or plots.	Dedicated table
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Dedicated table
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (*e.g.* confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Dedicated table
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Dedicated table
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Dedicated table
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Dedicated table
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Followed
	23b	Discuss any limitations of the evidence included in the review.	Followed
	23c	Discuss any limitations of the review processes used.	Followed
	23d	Discuss implications of the results for practice, policy, and future research.	Followed
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	The review was not registered
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Protocol was not prepared
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	None
Competing interests	26	Declare any competing interests of review authors.	None

(Table 1) contd.....

Section and Topic	Item #	Checklist Item	Location where Item is Reported
TITLE			
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

Table S2. Search strategies for electronic databases.

Database	Search Strategy
PubMed (MEDLINE)	#1 “Bacteria” [MESH] OR (Eubacteria) #2 “Dental Plaque” [MESH] OR (Plaque, Dental) #3 “Microbiota” [MESH] OR (Microbiotas) OR (Microbial Community) OR (Community, Microbial) OR (Microbial Communities) OR (Microbial Community Composition) OR (Community Composition, Microbial) OR (Composition, Microbial Community) OR (Microbial Community Compositions) OR (Microbial Community Structure) OR (Community Structure, Microbial) OR (Microbial Community Structures) OR (Microbiome) OR (Microbiomes) OR (Human Microbiome) OR (Human Microbiomes) OR (Microbiome, Human) #4 “Maxillomandibular Fixation” [MESH] OR (Jaw Fixation Techniques) OR (Fixation Technique, Jaw) OR (Fixation Techniques, Jaw) OR (Technique, Jaw Fixation) OR (Techniques, Jaw Fixation) OR (Jaw Fixation Technics) OR (Fixation Technic, Jaw) OR (Fixation Technics, Jaw) OR (Jaw Fixation Technic) OR (Technic, Jaw Fixation) OR (Technics, Jaw Fixation) OR (Fixation, Maxillomandibular) OR (Fixations, Maxillomandibular) OR (Maxillomandibular Fixations) #5 “Orthognathic Surgery” [MESH] OR (Orthognathic Surgeries) OR (Surgeries, Orthognathic) OR (Surgery, Orthognathic) #6 “Operative Procedures” [MESH] OR (Surgical Procedures, Operative) OR (Operative Surgical Procedures) #7 “Evidence-Based Practice” [MESH] OR (Evidence-Based Health Care) #8 #1 OR #2 OR #3 #9 #6 AND #7 #10 #4 AND #8 #11 #5 AND #8 #12 #5 AND #9
SCOPUS	#1 “Bacteria” [MESH] OR (Eubacteria) #2 “Dental Plaque” [MESH] OR (Plaque, Dental) #3 “Microbiota” [MESH] OR (Microbiotas) OR (Microbial Community) OR (Community, Microbial) OR (Microbial Communities) OR (Microbial Community Composition) OR (Community Composition, Microbial) OR (Composition, Microbial Community) OR (Microbial Community Compositions) OR (Microbial Community Structure) OR (Community Structure, Microbial) OR (Microbial Community Structures) OR (Microbiome) OR (Microbiomes) OR (Human Microbiome) OR (Human Microbiomes) OR (Microbiome, Human) #4 “Maxillomandibular Fixation” [MESH] OR (Jaw Fixation Techniques) OR (Fixation Technique, Jaw) OR (Fixation Techniques, Jaw) OR (Technique, Jaw Fixation) OR (Techniques, Jaw Fixation) OR (Jaw Fixation Technics) OR (Fixation Technic, Jaw) OR (Fixation Technics, Jaw) OR (Jaw Fixation Technic) OR (Technic, Jaw Fixation) OR (Technics, Jaw Fixation) OR (Fixation, Maxillomandibular) OR (Fixations, Maxillomandibular) OR (Maxillomandibular Fixations) #5 “Orthognathic Surgery” [MESH] OR (Orthognathic Surgeries) OR (Surgeries, Orthognathic) OR (Surgery, Orthognathic) #6 “Operative Procedures” [MESH] OR (Surgical Procedures, Operative) OR (Operative Surgical Procedures) #7 “Evidence-Based Practice” [MESH] OR (Evidence-Based Health Care) #8 #1 OR #2 OR #3 #9 #6 AND #7 #10 #4 AND #8 #11 #5 AND #8 #12 #5 AND #9

Table S3. Summary table of studies excluded in this systematic review.

Excluded Studies	Exclusion Reasons
Pagotto *et al*., 2017 [1]	Systematic Review and Meta-Analysis
Alkaabi *et al*., 2022 [2]	Systematic Review and Meta-Analysis
Olate *et al*., 2016 [3]	Systematic Review
Olate *et al*., 2017 [4]	Systematic Review
Apostolakis *et al*., 2022 [5]	Narrative Review
Jayaratne *et al*., 2010 [6]	Systematic Review

(Table 3) contd.....

Excluded Studies	Exclusion Reasons
Veldhuis *et al*., 2017 [7]	Systematic Review
Francisco *et al*., 2020 [8]	Systematic Review
Joss *et al*., 2010 [9]	Systematic Review
Joss *et al*., 2010 [10]	Systematic Review
Philip *et al*., 2022 [11]	Systematic Review
dos Santos Canellas *et al*., 2016 [12]	Systematic Review
Hu *et al*., 2021 [13]	Case Report
Maurer *et al*., 2002 [14]	Case Report

Table S4. Criteria for judging risk of bias in the "Risk of bias" assessment tool.

Random Sequence Generation	
Criteria for a judgement of 'Low risk' of bias.	The investigators describe a random component in the sequence generation process.
Criteria for the judgement of 'High risk' of bias.	The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach. Other non-random approaches happen much less frequently than the systematic approaches mentioned above and tend to be obvious. They usually involve judgement or some method of non-random categorization of participants.
Allocation Concealment	
Criteria for a judgement of 'Low risk' of bias.	Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation.
Criteria for the judgement of 'High risk' of bias.	Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias.
Blinding	
Criteria for a judgement of 'Low risk' of bias.	Any one of the following: - No blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding; - Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken; - No blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding; - Blinding of outcome assessment ensured, and unlikely that the blinding could have been broken.
Criteria for the judgement of 'High risk' of bias.	Any one of the following: - No blinding or incomplete blinding, and the outcome is likely to be influenced by lack of blinding; - Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken, and the outcome is likely to be influenced by lack of blinding; - No blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding; - Blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding.
Incomplete Outcome Data	
Criteria for a judgement of 'Low risk' of bias.	Any one of the following: - No missing outcome data; - Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); - Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; - For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; - For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; - Missing data have been imputed using appropriate methods.

(Table 4) contd.....

Random Sequence Generation	
Criteria for the judgement of 'High risk' of bias.	Any one of the following: - Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; - For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; - For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; - 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomization; - Potentially inappropriate application of simple imputation.
Selective Reporting	
Criteria for a judgement of 'Low risk' of bias.	Any one of the following: - The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; - The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).
Criteria for the judgement of 'High risk' of bias.	Any one of the following: - Not all of the study's pre-specified primary outcomes have been reported; - One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (*e.g.*, subscales) that were not pre-specified; - One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); - One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; - The study report fails to include results for a key outcome that would be expected to have been reported for such a study.

Table S5. Evidence of studies included in this systematic review.

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Chen *et al*., 2015 [15]	A 6-month double-blind randomized controlled clinical trial with 48 participants requiring a Le Fort I osteotomy to correct skeletal III class discrepancy, whose 24 patients received modified alar base cinch technique (*Trial Group*), and 24 patients received conventional alar base cinch technique (*Control Group*)	*Inclusion criteria:* non-growing Taiwanese patients over 18 years of age who underwent a Le Fort I maxillary osteotomy *Exclusion criteria:* associated syndromic diagnosis, cleft of the lip or palate, dentofacial trauma, or previous nasal septum or nasal tip operations	After orthognathic surgery, to assess the effectiveness and resulting postoperative changes in the nasolabial region of two alar base cinch suture techniques	*Results:* increase of 0.81 ± 1.87 mm in the cutaneous height of the upper lip and a decrease of 0.76 ± 1.56 mm in the lower prolabial width (*Trial Group*, $P<0.05$) increase of 0.31 ± 1.31 mm in nasal width and an increase of 0.97 ± 1.60mm in columellar length (*Control Group, P*>0.05) *Conclusions: b*oth alar base suture techniques are effective at controlling nasolabial form changes resulting from class III dual-jaw orthognathic surgery

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Barbosa Cavalcanti *et al*., 2022 [16]	A 3-month single-blind randomized controlled clinical trial with 40 participants requiring a Le Fort I osteotomy to correct skeletal III class discrepancy, whose 20 patients submitted to internal alar base suture (*Control Group*), and 20 patients submitted to external alar base suture (*Trial Group*)	*Inclusion criteria:* patients undergo orthognathic surgery of the maxilla with transoral vestibular approach, Le Fort I osteotomy, and in the intraoperative period they would be submitted to alar cinch suture *Exclusion criteria:* the presence of cleft lip and/or palate, history of facial fracture, or patients undergoing rhinoplasty surgery after orthognathic surgery and before final clinical evaluation, postoperative dehiscence from access, and participants who withdraw from the survey	To evaluate the enlargement of the nasal base of patients undergoing Le Fort I osteotomy, as well as compare two techniques of alar cinch suture, after movements performed in bone tissues in orthognathic surgery	*Results:* increase in the alar base width in both groups, with a significant difference between the means (P<0.001). It was observed that the external technique (*Group 2*) better-controlled alar base width after Le Fort I osteotomy. *Conclusions:* the external technique was more effective when compared to the internal technique in controlling the enlargement of the alar base width
Ruf *et al*., 2004 [17]	A 20-month clinical trial with 69 participants II class I division malocclusions, which underwent orthognathic surgery (*Control Group*, 46 patients), and Herbst approach (*Trial Group*, 23 patients)	*Inclusion criteria:* NR *Exclusion criteria:* NR	To assess to what extent adult Herbst treatment is an alternative to orthognathic surgery	*Results:* skeletal and soft tissue facial profile convexity was reduced significantly in both groups (P<0.05), but the amount of profile convexity reduction was larger in the surgery group. The success and predictability of Herbst treatment for occlusal correction was as high as for surgery *Conclusions*: Herbst treatment can be considered an alternative to orthognathic surgery in borderline adult skeletal Class II malocclusions, especially when a great facial improvement is not the main treatment goal

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Bertossi *et al*., 2013 [18]	A 2-month randomized controlled clinical trial with 55 participants underwent orthognathic surgery using a piezosurgery device (*Trial Group*), and 55 patients treated using a reciprocating saw (*Control Group*) to correct dentoskeletal deformity and/or mandibular prognathism	*Inclusion criteria: d*entoskeletal deformity and/or mandibular prognathism *Exclusion criteria:* systemic disease that contraindicate surgical treatment, bone pathology, use of a drug that could interfere with bone healing, a history of psychiatric illness, or allergy to drugs used in the study	To compare the use of the piezoelectric osteotomy as an alternative to the conventional approach in terms of surgery time, intraoperative blood loss, cut quality, nerve injury, and costs	*Results:* the surgical time in *Trial Group* was reduced, with a mean for the mandibular osteotomy between 3 minutes 31 seconds and 5 minutes 2 seconds, whereas in *Control Group*, the surgical time was between 7 minutes 23 seconds and 10 minutes 22 seconds. The surgical time in *Trial Group* for the Le Fort I osteotomy was between 5 minutes 17 seconds and 7 minutes 55 seconds in *Trial Group* and between 8 minutes 38 seconds and 15 minutes 11 seconds in *Control Group*. All patients in group A had a low blood loss (<300 mL) *versus* patients of *Control Group* who had a medium to high blood loss (400 mL). Inferior alveolar nerve sensation was retained in 98.2% of *Trial Groupversus* 92.7% in *Control Group* at 6 months postoperative testing *Conclusions:* Piezoelectric osteotomy reduced surgical time, blood loss, and inferior alveolar nerve injury in bimaxillary osteotomy. Absence of macrovibrations makes the instrument more manageable and easier to use and allows greater intraoperative control with higher safety in cutting in difficult anatomical regions
Choi *et al*., 2015 [19]	A 12-month prospective clinical trial with 56 participants affected by skeletal class III malocclusion and divided into two groups: surgery-first approach group (*Trial Group*, 32 patients), and orthodontics-first approach group (*Control Group*, 24 patients)	*Inclusion criteria:* surgery-first orthognathic approach indications by presurgical simulation model setup *Exclusion criteria:* severe dental crowding, arch discrepancy, syndromic patients, and cleft-related dentofacial deformities, based on presurgical model setup	To compare the standard and surgery-first approaches as well as test a novel simulation for treating class III malocclusion patients with a surgery-first approach	*Results:* surgery-first approach without presurgical orthodontic treatment is possible and can give similar results to standard orthognathic surgery. The statistical analysis showed that changes in skeletal cephalometric landmarks were similar between the surgery-first and standard approach groups, according to each period. The cephalometric landmarks relating to the dental component showed changes between treatment groups at different time points but similar final values *Conclusions*: the surgery-first orthognathic approach without presurgical orthodontic treatment was found to be predictable and applicable to treat class III dentofacial deformities

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Li *et al*., 2022 [20]	A 2-years randomized controlled clinical trial with 98 participants scheduled for orthognathic surgery, whose 49 patients were randomized into IVRO group (*Trial Group*), and 49 patients were randomized into SSRO group (*Control Group*)	*Inclusion criteria:* 18 years of age or above, Stability of skeletal growth, as shown by serial lateral and frontal cephalometric radiographs at 1 year apart, scheduled to undergo a mandibular setback surgical procedure, planned as a part or whole of their orthognathic surgery *Exclusion criteria:* Craniofacial syndromes, Systemic conditions predisposing to infection or contraindicated for intermaxillary fixation, History of previous orthognathic surgery, Pre-existing inferior alveolar nerve, or lingual nerve deficit	To compare skeletal stability in the antero-posterior and vertical dimensions between IVRO and SSRO as mandibular setback surgery, within two postoperative years.	*Results:* more surgical relapse in the horizontal direction in the SSRO group than in the IVRO group (0.27 mm ± 0.34 mm) *vs* (0.10 mm ± 0.29 mm) (P=0.014). More absolute changes in the SSRO group than in the IVRO group at postoperative 2 years (P=0.045). The amounts of change as percentages of total mandibular setback were 1.3% and 3.5% in the IVRO group and SSRO group, respectively. There were no differences in vertical changes between the two groups at any time points. *Conclusions:* the horizontal stability at was shown to be superior in the IVRO group compared with the SSRO group in the correction of mandibular prognathism during the 2-year follow-up
Mahmoud *et al*., 2022 [21]	A 6-month single-blind randomized controlled clinical trial with 24 participants requiring bimaxillary orthognathic surgery to correct skeletal III class malocclusions, which 12 patients underwent mandible-first approach (*Trial Group*), and 12 patients underwent maxilla-first approach (*Control Group*)	*Inclusion criteria:* skeletal class III malocclusion that necessitated bimaxillary orthognathic surgery, absence of any systemic disease, approval to be included in the trial and signature on the informed consent, and no signs or symptoms of temporomandibular joint disorders *Exclusion criteria:* cleft lip and palate, receiving chemotherapy or radiotherapy, and refusal to be included in the trial	To assess whether maxilla-first or mandible-first orthognathic sequence in bimaxillary orthognathic surgery results in increased maxillary stability in patients with skeletal class III malocclusion	*Results: s*tatistical analysis of the lateral cephalometric measurements reached statistical significance differences between immediately after surgery) and 6-month after in both groups (P<0.05). Clinically, this was not significant as the mean difference at parameters concerned with maxillary advancement and rotation is about 2 mm only *Conclusions*: the study showed that the mandible-first approach is a reliable surgical procedure that produces similar results to the maxilla-first approach in the management of skeletal class III malocclusion
Van Hemelen *et al*., 2015 [22]	A 4-month double-blind randomized controlled prospective clinical trial with 66 participants II class malocclusion (58 patients), and III class malocclusion (8 patients), whose 46 patients underwent a bimaxillary osteotomy, 17 patients underwent a bilateral sagittal split osteotomy of the lower jaw, and 3 patients underwent a Le Fort 1 osteotomy. 31 patients were treated according to the 3D planning scenario (*Trial Group*), and 35 patients were treated according to the 2D planning protocol (*Control Group*)	*Inclusion criteria:* NR *Exclusion criteria:* NR	To compare the accuracy of a traditional 2D technique and a 3D computer-aided prediction method	*Results:* statistically significant difference between 2D and 3D soft tissue planning (P<0.05), but no statistically significant difference between 2D and 3D planning and the actual soft tissue outcome (P>0.05) *Conclusions*: the 3D planning approach provides more accurate soft tissue planning, even if the 2D orthognathic planning is comparable to 3D planning when it comes to hard tissue planning

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Chen, H. *et al*., 2021 [23]	A 1-week single-blind randomized controlled clinical trial with 61 patients divided into three groups: CROS Group (20 patients), DOS Group (21 patients), and DT Group (20 patients). Patients were affected by maxillary deficiency with mandibular excess (15, CROS Group, 13, DOS Group, 12, DT Group), maxillary excess with mandibular deficiency (3, CROS Group, 5, DOS Group, 4, DT Group), and asymmetric deformity (2, CROS Group, 3, DOS Group, 4, DT Group)	*Inclusion criteria:* age between 18 and 40 years, diagnosed with a dento-maxillofacial deformity requiring bimaxillary surgery *Exclusion criteria:* cleft lip and palate or craniofacial syndrome, ento- maxillofacial deformities were caused by trauma, tumour, or iatrogenic factors, previous orthognathic surgery, patients scheduled to undergo segmental Le Fort I osteotomy	To compare the accuracy of three methods for transferring the maxillary plan to the surgical procedure (conventional resin occlusal splints, digital occlusal splints, and digital templates).	*Results:* the distance was significantly smaller in the DT group (1.17±0.66mm) when compared to both the CROS group (2.55 ± 0.95mm, $P<0.05$) and DOS group (2.15 ± 1.12mm, $P<0.05$). However, the difference between the CROS group and DOS group was not statistically significant. These findings indicate that using digital templates results in the best performance in transferring the surgical plan to the operation environment as compared to the other two types of splints *Conclusions*: the application of digital templates could provide a reliable treatment option
Li *et al*., 2021 [24]	A 1-week triple-blind randomized controlled clinical trial with 58 participants affected by skeletal classes II–III malocclusions requiring orthognathic surgery and divided into two groups: patient-specific implant group (*Trial Group*, 27 patients), and CAD/CAM surgical splints (*Control Group*, 31 patients)	*Inclusion criteria:* skeletal classes II–III classes diagnosis and requiring orthognathic surgery, including maxillary surgery *Exclusion criteria:* previous orthognathic surgery, previous maxillary or mandibular trauma, maxillofacial tumors, segmental maxillary surgery, oral soft-tissue defects, infections, craniofacial syndromes, bone metabolism disturbances, allergies to titanium implants, and pregnancy	To assess whether using patient-specific implants would result in a more accurate maxilla position than using CAD/CAM surgical splints in orthognathic surgery	*Results:* the maxilla position discrepancy was 1.41 ± 0.58 mm in the patient-specific implant group and 2.20 ± 0.94 mm in the splint group; the between-group difference was significant ($P<0.001$). For the *Trial Group*, the largest translation discrepancy was 1.02 ± 0.66 mm in the anteroposterior direction, and the largest orientation discrepancy was 1.85 ± 1.42 degrees in pitch. For the *Control Group*, the largest translation discrepancy was 1.23 ± 0.93 mm in the mediolateral direction, and the largest orientation discrepancy was 1.72 ± 1.56 degrees in pitch *Conclusions*: using patient-specific implants in orthognathic surgery resulted in a more accurate maxilla position than CAD/CAM surgical splints
Schneider *et al*., 2019 [25]	Prospective controlled clinical trial with 21 participants affected by skeletal II class malocclusion underwent customized VSP bimaxillary orthognathic surgery (9 patients), and CSP orthognathic surgery (12 patients)	*Inclusion criteria:* healthy adult patients with skeletal class II malocclusion treated with bimaxillary surgery *Exclusion criteria:* history of facial trauma, hemifacial microsomia, craniosynostosis, or degenerative or inflammatory conditions	To analyze the accuracy of splints, the time required for surgery, and the costs of virtual *versus* conventional planning in bimaxillary orthognathic surgery	*Results:* VSP appears to be a more accurate method for orthognathic treatment planning with significant differences in the angle outcome ($P<0.001$). There were significant differences in splint accuracy in favor of CAD/CAM splints ($P=0.007$). VSP significantly reduced the duration of operation ($P=0.041$). Nevertheless, VSP is more expensive than CSP *Conclusions*: 3D models of the jaws and pre-bent osteosynthesis, there is a noticeable reduction in the duration of the operation in conjunction with an improvement in accuracy

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Cui *et al*., 2022 [26]	A 1-week triple-blind prospective randomized clinical trial with 40 participants divided into two groups: IMFS implantation with digital guide (*Trial Group*, 20 patients), and IMFS implantation without digital guide (*Control Group*, 20 patients). Patients were affected by maxillary-mandibular malformations. Postoperatively, cone-beam computed tomography was performed to compare root proximity of IMFSs between the two groups and verify the accuracy of IMFS placement	*Inclusion criteria:* permanent dentition with a stable occlusal relationship, preoperative orthodontic treatment performed for skeletal deformities, extraction not indicated for teeth other than the third molars *Exclusion criteria:* patients have severe systemic diseases such as osteoporosis and diabetes, maxillomandibular bone defects because of maxillofacial injury or surgery for maxillofacial tumors/cysts, unclear CBCT images or unwillingness to undergo CBCT	To assess the accuracy of IMFS implantation with a digital guide to reduce the occurrence of root damage	*Results: i*n the *Trial Group*, there was no case of root damage, the incidence of the periodontal ligament injured was 22.1%, and 77.9% IMFSs were placed without contacting adjacent anatomic structures. In the *Control Group*, the incidence of root damage had been up to 20.8%, 31.7% IMFSs injured the periodontal ligament, and only 47.5% IMFSs were placed between the roots (P<0.001) *Conclusions*: IMFSs can be placed more accurately with surgical guides, reducing the incidence of root and periodontal ligament damages
Wang *et al*., 2022 [27]	A 4-month double-blind prospective randomized controlled clinical trial with 28 participants affected by maxillary deficiency, maxillary excess, maxillary asymmetry deformity divided into two groups: EOG Group (*Trial Group*, 14 patients), and TOG Group (*Control Group*, 14 patients). Virtual designs and actual postoperative outcomes were compared by cone-beam computed tomography	*Inclusion criteria:* patients with maxillary deformity requiring correction by Le Fort 1 osteotomy, who were willing to undergo computer tomography for diagnosis and treatment, and who voluntarily signed the informed consent form *Exclusion criteria:* patients with cranio-maxillofacial malformation syndrome, who had undergone maxillary Le Fort 1 osteotomy previously and required reoperation, with maxillary tumors, and with maxillary sinusitis	To compare the accuracy of new type of osteotomy guide (EOG) with traditional osteotomy guide (TOG) assessing the control over the osteotomy on the inner and posterior walls of the maxilla	*Results:* All positioning deviations of both osteotomy guides were <0.3 mm (P>0.05). The osteotomy depths on the inner and posterior walls with the EOG and TOG deviated by 0.789±1.179 and 1.811±1.345 mm (P=0.004) and 0.648±0.999 and 1.262±0.942 mm (P=0.030), respectively. The angles of deviation of the osteotomy direction on the inner and posterior walls by the EOG and TOG were 2.025±2.434 and 5.069±2.391 degrees (P<0.001) and 2.772±2.979 and 8.653±4.690 degrees (P<0.001), respectively *Conclusions*: the EOG was more accurate than TOG for manipulating osteotomy direction and depth on the inner and posterior maxillary walls. Thus, EOG could ensure higher surgical safety than TOG

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Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Chen, C. *et al*., 2021 [28]	Randomized controlled clinical trial with 52 participants randomly divided into two groups: orthognathic surgery assisted with Ci-Navi (*Trial Group*, 26 patients), and conventional surgery (*Control Group*, 26 patients). Patients were affected by skeletal classes I (3), II (8), III (41) malocclusions, facial asymmetry and/or malformation (26), anterior open bite (10)	*Inclusion criteria:* adult patients with congenital dental maxillofacial deformity scheduled to undergo bimaxillary orthognathic surgery, surgery assisted with Ci-Navi or intermediate splint *Exclusion criteria:* cleft lip/palate, skeletal deformities resulting from trauma or tumor resection, single jaw operation	To evaluate the accuracy of Ci-Navi compared with that of conventional navigation methods in bimaxillary orthognathic surgery	*Results:* In *Trial Group*, the overall mean linear difference was 0.79 mm (0.62 mm for the maxilla and 0.88 mm for the mandible) and the overall mean angular difference was 1.20°. In 23 cases, the difference from the upper incisor point to the Frankfort horizontal plane, midfacial sagittal plane, and coronal plane was less than 1 mm. In *Control Group*, the overall mean linear difference was 1.98 mm (1.76 mm for the maxilla and 2.02 mm for the mandible) and the overall mean angular difference was 2.08°. The difference from the upper incisor point to the Frankfort horizontal plane, midfacial sagittal plane, and coronal plane was less than 1 mm in 15 cases *Conclusions*: This study demonstrates the utility of Ci-Navi is superior to the conventional methods in aiding the accurate repositioning of bony segments in bimaxillary orthognathic surgery
Pelo *et al*., 2017 [29]	A 1-month randomized controlled clinical trial with 30 participants affected by dentoskeletal malformations (skeletal class II–III malocclusions) requiring orthognathic surgery, whose 15 patients underwent orthognathic surgery according to the surgery-first approach (*Trial Group*), and 15 patients underwent conventional orthognathic surgery (*Control Group*). Variables were assessed through the Orthognathic Quality of Life Questionnaire and the Oral Health Impact Profile questionnaire	*Inclusion criteria:* presence of maxillomandibular malformation, mild to no dental crowding, and mild Spee curve *Exclusion criteria:* other facial corrective surgery, any compensatory orthodontic treatment, chronic disease, syndrome involving the craniofacial area, and malformations secondary to clefts	To investigate and evaluate the differences detected by the patients between the traditional orthognathic approach and the surgery-first one in terms of level of satisfaction and quality of life	*Results:* significant differences in terms of the Orthognathic Quality of Life Questionnaire (P<0.001) and the Oral Health Impact Profile (P<0.001) scores within groups between the first and last administrations of both questionnaires. Differences in the control group between first and second administrations were also significant. Questionnaire scores showed an immediate increase of quality of life after surgery in the surgery-first group and an initial worsening during orthodontic treatment in the traditional approach group followed by postoperative improvement *Conclusions*: worsening of the facial profile during the traditional orthognathic surgery approach decompensation phase has a negative impact on the perception of patients' quality of life. Surgeons should consider the possibility of a surgery-first approach to prevent this occurrence

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Bengtsson *et al*., 2018 [30]	A 1-year double-blind randomized controlled clinical trial with 57 participants affected by skeletal III class malocclusions requiring orthognathic surgery, whose 28 patients underwent 3D planning technique orthognathic surgery (*Trial Group*), and 29 patients underwent 2D planning technique orthognathic surgery (*Control Group*). Questionnaires on the patient's HRQoL were distributed preoperatively and 12 months after surgical treatment	*Inclusion criteria:* completion of presurgical orthodontic treatment before surgical treatment *Exclusion criteria:* systemic musculoskeletal diseases, drug abuse, poor psychic status, or disease in the temporomandibular joint	To investigate possible differences of HRQoL after orthognathic treatment, depending on either a 2D or a 3D planning technique	*Results:* no statistically significant difference regarding HRQoL was found between the studied planning techniques. Difference between pretreatment and posttreatment that increased in both groups but to a higher level in the 3D group. A difference between pretreatment and posttreatment HRQoL was shown for both groups, indicating increased quality of life after treatment *Conclusions*: improvements of HRQoL were shown after treatment independent of which planning technique, 2D or 3D, was used. No statistically significant difference was found between the planning techniques
Hanafy *et al*., 2019 [31]	A 6-month double-blind randomized controlled clinical trial with 32 participants requiring bimaxillary orthognathic surgery to correct skeletal II–III class malocclusions, which 12 patients underwent CAD/CAM guides orthognathic surgery (*Trial Group*), and 12 patients underwent classic interocclusal wafer orthognathic surgery (*Control Group*). Patients were assessed using OQLQ preoperatively and 6 months postoperatively	*Inclusion criteria:* absence of systemic condition that may interfere with bone healing or make the patient unfit for surgery *Exclusion criteria:* previous extensive jaw surgery, cleft lip, and palate, physical or mental disability or active symptoms of temporomandibular dysfunction	To assess quality of life following orthognathic surgery using CAD/CAM bone splints compared to the classic occlusal wafers in patients with dentofacial deformities	*Results:* mean OQLQ overall score change of 24.375±11.96 took place in *Trial Group* patients while *Control Group* showed a mean change of 23±8.39 but computer-assisted surgery did not show any significant improvement over the classic approach ($P>0.05$) *Conclusions*: evident improvement in quality of life following orthognathic surgery compared to before surgery
Jaeger *et al*., 2020 [32]	A 6-month triple-blind randomized controlled clinical trial with 30 participants affected by dentofacial deformities with SARME or bimaxillary orthognathic surgery indications and divided into three groups: scalpel group (10 patients), electrocautery group (10 patients), and diode Laser group (10 patients)	*Inclusion criteria:* adult patients who presented dentofacial deformities with surgical indications: SARME or bimaxillary orthognathic surgery *Exclusion criteria:* patients who were using anti-inflammatories or analgesic medications during the period of surgery	To evaluate the efficacy and safety of diode laser during circumvestibular incisions for Le Fort I osteotomy in orthognathic surgeries in comparison with conventional techniques using electrocautery and scalpel	*Results: r*egarding bleeding, the incisions performed with diode laser promoted a lower bleeding rate compared with scalpel and electrocautery ($P=0.00$). The diode surgical laser was effective during the incision procedure but required a longer time to perform the incisions compared with the other techniques evaluated ($P<0.05$). No statistically significant difference was detected between groups regarding total surgical time or other safety parameters ($P>0.05$) *Conclusions*: diode laser proved to be effective and safer during circumvestibular incisions for Le Fort I osteotomy than conventional devices

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Camacho *et al*., 2020 [33]	A 2-week single-blind randomized controlled clinical trial with 56 participants affected by dentofacial deformities with mandibular orthognathic surgery indication and divided into three groups: post-mandibular orthognathic surgery who will be treated after the procedure with 250 mg naproxen sodium every 8 hours and 6 doses of low-level laser therapy with an energy density of 85.71 J/cm^2, starting two days after the procedure and every other day until the 13th day (*Group 1*, 19 patients), post-mandibular orthognathic surgery who will be treated after the procedure with 250 mg naproxen sodium every 8 hours and 6 doses of PBMT with an energy density of 68.33 J/cm^2, starting two days after the procedure and every other day until the 13th day (*Group 2*, 18 patients), post-mandibular orthognathic surgery who will be treated after the procedure with 250 mg naproxen sodium every 8 hours for 6 days (*Control Group*, 19 patients)	*Inclusion criteria:* ages 18 to 40 years at the time of starting the treatment, without systemic diseases, programmed for certain orthognathic surgery, and were not taking additional medications during the experimental phase *Exclusion criteria:* trauma, orthognathic surgery patients or craniofacial syndrome, present metabolic illness, or hormonal alteration in the experimental period, breaking an appointment or follow-up, complications intra and post-orthognathic surgery, unwanted mandibular bone fracture, bleeding, full section of the inferior alveolar nerve, patients allergic to NSAIDs, patients who are pregnant, and patients with a cardiovascular surgical history: placement of pacemakers, prosthetic valve, and patients with neurological disorders such as epilepsy	To compare the effect on post-surgical oedema after mandibular orthognathic surgery, between two different laser power densities and oral medication with non-steroidal anti-inflammatory	*Results:* the differences between the groups were generally not significant (P>0.05) except for commissure - right and left gonion when compared *Group 1vsControl Group* (P<0.05) and *Group 2vsControl Group* (P<0.05). Initial changes between groups were significantly different except for the measurement from commissure to right tragus *Group 1vsControl Group* (P=0.411) and from commissure to left tragus *Group 2vsControl Group* (P=0.94). The faster resolution of the oedema occurred in *Group 2* group *Conclusions*: PTBM with an energy density of 68.33J/cm^2 was the most effective adjuvant to oral medication with non-steroidal anti-inflammatory, to decrease post-surgical oedema after mandibular orthognathic surgery
de Rezende *et al*., 2018 [34]	A 3-week randomized controlled clinical trial with 82 participants affected by dental-skeletal facial deformities and divided into two groups: 40 patients underwent PBMT (*Trial Group*, 9 patients underwent SARME, 15 patients underwent maxillary or mandibular surgery, and 16 patients underwent bimaxillary surgery), 42 patients did not undergo PBMT (*Control Group*, 8 patients underwent SARME, 15 patients underwent maxillary or mandibular surgery, and 19 patients underwent bimaxillary surgery). PBMY was applied using a GaAlAs diode Laser (780 nm, 100 J/cm^2, 100 mW, 20 s/point, 2 J/point, onto 14 extraoral points on either side of the face, immediately after the end of the surgical procedure and 24, 48, and 72 h thereafter	*Inclusion criteria:* NR *Exclusion criteria:* NR	To evaluate the effect of PBMT using a GaAlAs diode Laser (780 nm) as an adjuvant therapy to improve mouth opening in the postoperative period of different modalities of orthognathic surgery	*Results:* there were no significant differences between the SARME and isolated maxillary/mandibular surgery groups. In the bimaxillary groups, average mouth opening was increased in all patients who received PBMT, significantly so in male patients *Conclusions*: PBMT with a GaAlAs diode laser (780 nm) did not affect postoperative mouth opening after SARME, isolated maxillary surgery, or isolated mandibular surgery. However, it improved mouth opening in men who had undergone bimaxillary orthognathic surgery

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Bevilacqua *et al*., 2016 [35]	A 2-week double-blind prospective randomized controlled clinical trial with 60 participants scheduled for periodontal flap surgery and divided into three groups: alcohol-free 0.12% CHX (20 patients), alcohol-free 0.2% CHX (20 patients), and alcohol-free 0.2% CHX with ADS (20 patients). Before surgery (T0), 7 days (T1) and 14 days (T2) after surgery, following variables were recorded: gingival parameters at the surgically treated sites (Full-Mouth Plaque Score, Full-Mouth Bleeding Score and Modified Gingival Index), tooth pigmentation measured, patient perception and acceptance of the mouthrinses	*Inclusion criteria:* good general health conditions, good plaque control with full mouth plaque score ≤25%, low levels of infection with full mouth bleeding ≤25% *Exclusion criteria:* systemic pathologies or use of medications that might interfere with healing of periodontal tissues, smoking habit, allergy to CHX, lack of written informed consent	To evaluate by a clinical spectrophotometric analysis the staining side effect of a 0.2% CHX mouthrinse containing an ADS compared with a 0.12% and a 0.2% CHX mouthrinse, after periodontal surgery	*Results:* no statistical differences were found for dental pigmentation among the mouthrinses over time nor for discomfort at each follow-up examination. A slightly less acceptance rate was observed for 0.2% CHX *Conclusions*: 0.2% CHX with ADS did not cause less brown pigmentation than the 0.2% CHX or than the 0.12% CHX, ADS CHX was as effective as CHX without ADS in reducing gingival signs of inflammation in the post-surgical early healing phase, 0.2% CHX showed the lowest score in terms of taste acceptance compared with 0.12% and ADS CHX
Gruber *et al*., 2005 [36]	A 7-month pilot clinical trial with 7 participants requiring a BSSRO with a combined orthognathic and surgical approach to correct skeletal classes II–III malocclusions	*Inclusion criteria:* NR *Exclusion criteria:* NR:	To present preliminary results and experiences using an ultrasonic bone-cutting device in BSSRO with particular attention to possible damages to the IAN	*Results:* Subjective neurosensory disturbances of the IAN showed a continuous decrease from 57.1% (eight sides) 2 months after the surgical procedure to 14.3% (2 sides) after 5 months and to 7.1% 7 months after BSSRO *Conclusions*: this preliminary clinical evaluation suggests that ultrasonic bone cutting is possible in orthognathic surgery at a high level of safety and precision. Long-term benefits regarding protection of neurosensory functions remain to be shown
Baan *et al*., 2016 [37]	A 3-weeks clinical trial with 10 participants requiring a bimaxillary surgery to correct skeletal II class discrepancy, which underwent CBCT scans 4 weeks before surgery and 1-3 weeks after surgery	*Inclusion criteria:* non-syndromic dysgnathia requiring bimaxillary osteotomy and the availability of preoperative and postoperative CBCT data *Exclusion criteria:* previous history of Le Fort I osteotomy or bilateral sagittal split osteotomy, cleft palate, and syndromic patients	To validate an innovative tool, the *OrthoGnathicAnalyser*, in patients who underwent bimaxillary osteotomies	*Results: l*ow intra-observer and inter-observer variations in measurement error (<0.25 mm) and high intraclass correlation coefficients (>0.97) were found, supportive of the observer independent character of the OrthoGnathicAnalyser *Conclusions*: this novel method provides a reproducible tool for the evaluation of bimaxillary surgery, making it possible to compare larger patient groups in an objective and time-efficient manner to optimize the current workflow in orthognathic surgery

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Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Badiali *et al*., 2020 [38]	A 1-month prospective clinical trial with 22 patients affecting by skeletal classes II–III malocclusions, class I facial asymmetry, anterior open bite. Three different positioning guide designs were compared in terms of osteosynthesis plate positioning and mandibular anatomical outcome. PSIs and positioning guides were designed according to virtual surgical plan and 3D printed using biocompatible materials. A CBCT scan was performed 1 month after surgery and postoperative mandibular models were segmented for comparison against the surgical plan	*Inclusion criteria:* NR *Exclusion criteria:* NR	To analyze the quality of mandibular anatomy reproduction using a mandible-first mandibular-PSI guided procedure	*Results:* correlations between obtained rami and plates discrepancies and between planned rami displacements and obtained rami discrepancies were calculated. Intraoperatively, all PSIs were successfully applied *Conclusions*: the procedure was found to be accurate in planned mandibular anatomy reproduction. Different guide designs did not differ in mandibular outcome precision. Plate positional discrepancies influenced the corresponding ramus position, mainly in roll angle and vertical translation. Ramus planned displacement was found to be a further potential source of inaccuracy, possibly due to osteosynthesis surface interference
Cascino *et al*., 2021 [39]	A 6-month retrospective randomized controlled clinical study with 100 participants requiring a combination of BSSRO and Le Fort 1 to correct skeletal classes II–III malocclusions, and divided in two groups 50 patients each (saw osteotomies group, piezo-osteotomies group)	*Inclusion criteria:* patients with either II or III malocclusion class, patients undergoing orthognathic surgery, signed informed consent, patients older than 21 years *Exclusion criteria:* previous orthognathic surgery, other orthognathic procedures including genioplasty, as well as simultaneously wisdom teeth extractions, history of facial trauma	To evaluate specific parameters: intra-operative time, facial swelling, degree of pain (VAS scale), recovery time and neurosensory disturbance in patients who underwent orthognathic surgery either using piezo or saw devices.	*Results:* intra-operative time is unchanged, but patients operated with the Piezo devices requested fewer painkilling medication and were dismissed on the second day after the surgery. Neurosensory recovery was statistically significant in the Piezo group (P<0.05) *Conclusions*: far less post-op swelling and the reduction in the use of painkillers lead to a speedier recovery in patients who underwent orthognathic surgery using Piezosurgery. These patients also recovered more sensitivity in the lower lip area
Kee *et al*., 2022 [40]	Retrospective clinical study with 64 participants affected by skeletal class III malocclusion and divided into two groups: 32 patients treated with orthognathic surgery and postsurgical orthodontic treatment (*Group 1*), and 32 patients treated with presurgical orthodontic treatment, orthognathic surgery, and postsurgical orthodontic treatment (*Group 2*). Cone-beam computed tomography scans were obtained before treatment, after presurgical orthodontic treatment, and after treatment for the COS group and were obtained before and after treatment for the SFA group. The measurements of vertical alveolar bone height and horizontal bone thickness at 4 levels and the alveolar bone area surrounding the mandibular incisors were compared according to the treatment progress and groups	*Inclusion criteria:* skeletal class III malocclusion, aged ≥18 years, ANB degree ≤0, crowding in the mandibular arch ≤3 mm, and CBCT scans were obtained before starting treatment, after presurgical treatment, and after treatment *Exclusion criteria:* patients with cleft lip and palate or other craniofacial syndrome, sever facial asymmetry, anterior spacing or tooth anomaly, and dilacerated roots and sever root resorptions	To investigate the alveolar bone changes around mandibular incisors in patients with skeletal Class III malocclusion treated with surgery-first orthognathic approach, and conventional orthognathic surgery using cone-beam computed tomography scans	*Results:* the vertical bone levels and horizontal bone thickness of the labial and lingual sides and the area of the alveolar bone around the mandibular incisors were reduced after treatment in both SFA and COS groups. Vertical bone loss was more prominent than horizontal bone loss after treatment in both groups, and alveolar bone loss was greater on the lingual side than on the labial side. There were no significant differences in alveolar bone changes around the mandibular incisor between the SFA and COS groups *Conclusions*: surgery-first orthognathic approach and conventional orthognathic surgery may trigger degeneration of the alveolar bone around the mandibular incisors after treatment in patients with mandibular prognathism

(Table 5) contd.....

Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Borikanphanitphaisan *et al*., 2021 [41]	A 1-week retrospective cohort clinical study with 57 participants affected by skeletal classes II–III malocclusions and skeletal class I asymmetry and divided into two groups: maxilla-first orthognathic surgery (*Group 1*, 31 patients), and mandible-first orthognathic surgery (*Group 2*, 26 patients). 1-week postoperative cone-beam computed tomographic craniofacial images were superimposed onto preoperative simulated images to measure the discrepancy of the three-dimensional cephalometric landmarks	*Inclusion criteria:* adult Taiwanese patients with dentofacial deformities necessitating bimaxillary orthognathic surgery, availability of preoperative and postoperative CAD/CAM images *Exclusion criteria:* association with craniofacial anomalies, concomitant temporomandibular joint surgery, absence of central incisors and first molars, postoperative complications, facial trauma, and incomplete medical records	To investigate the accuracy of bimaxillary orthognathic surgery regarding different sequencing (maxilla-first or mandible-first surgery) and different thicknesses of intermediate splints	*Results:* mandible-first surgery resulted in more accuracy in the vertical dimension. Thick intermediate splints provided better control (less error) of upper central incisors in the sagittal position (thick splint, 1.38 ± 1.17 mm; thin splint, 2.13 ± 1.38 mm). However, overall accuracy was not affected by splint thickness *Conclusions*: mandible-first surgery was more precise in the vertical dimension. Thick intermediate splints seemed to yield better control of central incisors in the sagittal position. However, under appropriate selection of intermediate splints to maintain interim condylar position, splint thickness has no effect on overall accuracy
Chen *et al*., 2022 [42]	A 1-week retrospective controlled clinical trial with 70 participants divided into two cohorts, DOS Cohort (33 patients), and DT Cohort (37 patients). Patients are affected by maxillary deficiency with mandibular excess (20, DOS Cohort, 19, DT Cohort), maxillary excess with mandibular deficiency (7, DOS Cohort, 8, DT Cohort), asymmetric deformity (6, DOS Cohort, 10, DT Cohort)	*Inclusion criteria:* age ranges from 18 to 40 years, diagnosed with skeletal dentofacial deformity and need bimaxillary orthognathic surgery to correct it *Exclusion criteria:* unilateral or bilateral cleft lip and palate, diagnosed with craniofacial syndrome, craniofacial deformities caused by tumor, trauma, or iatrogenic factors, previously underwent orthognathic surgery, scheduled for maxillary segmental osteotomy	To compare the accuracy when using printed occlusal splints *versus* templates in simple and complicated cases	*Results:* the average deviation was significantly smaller in the complicated cases in the DT Cohort (1.37 mm; 95% confidence interval, 1.08-1.66 mm) than that in the DOS cohort (2.47 mm; 95% confidence interval, 1.92-3.02 mm) (P=0.002). The deviations in anteroposterior direction of complicated cases in the DT cohort were smaller than the corresponding values of the DOS cohort (P=0.035). There is no significant difference between the deviation values of simple and complicated cases using templates (P=0.116) *Conclusions*: in complicated cases, printed guiding templates exhibit better accuracy for repositioning the maxilla than printed occlusal splints, and the effect of templates in different cases proved to be stable
Weinspach *et al*., 2012 [43]	A 6-week prospective clinical study with 15 participants affected by skeletal classes II–III malocclusions requiring single jaw or bimaxillary orthognathic surgery. Plaque index and concentrations of 11 periodonto-pathogenic bacteria were recorded one day prior to surgery (T0), one week (T1), and six weeks (T2) post-surgery. In addition, a complete periodontal examination including PPD, GR, CAL, BOP, and WKG was conducted at T0 and T2	*Inclusion criteria:* NR *Exclusion criteria:* NR	To evaluate the influence of orthognathic surgery on the development of periodontal and microbiological changes	*Results:* a significant increase of plaque index (T0-T1, P=0.037) was followed by a significant decrease (T1-T2, P=0.017). Apart from *Eikenella corrodens* (P=0.036), no significant microbiological changes were recorded. PPD significantly increased on oral sites (P=0.045) and GR especially on buccal sites (P=0.001). In the incision area the development of GR was significantly higher on the buccal than on the oral sites. Both gingival biotypes were affected by GR *Conclusions*: orthognathic surgery causes statistically significant changes of periodontal parameters, but these changes do not necessarily impair the aesthetic appearance of the gingival margin

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Authors	Study Design	Inclusion and Exclusion Criteria	Aim	Results and Conclusions
Haffajee *et al*., 2008 [44]	A 2-year retrospective clinical study with 4745 Supragingival plaque samples were taken from 187 subjects at baseline. 55 patients provided supragingival plaque samples at 1-7 days after professional tooth cleaning; 93 patients provided 8044 samples between 3-24 months post-therapy. All samples were individually analyzed for their content of 40 bacterial species using checkerboard DNA-DNA hybridization. Microbial associations among species were sought using cluster analysis and community ordination techniques for the three groups separately	*Inclusion criteria:* periodontally health, evidence of prior attachment loss, 20 teeth at least *Exclusion criteria:* pregnancy, periodontal therapy or antibiotics in the previous 3 months, any systemic condition which might have affected the progression or treatment of periodontitis, and the need for premedication for monitoring or therapy	To examine microbial communities in supragingival biofilm samples	*Results:* six complexes were formed for the baseline samples. Similar complexes were formed for the samples taken 3-24 months post-therapy. However, distinct changes were observed in microbial communities in samples taken during the 7 days of plaque redevelopment. The complexes related to clinical parameters of periodontal disease *Conclusions*: there were specific microbial complexes in supragingival plaque that were like those found in subgingival plaque samples with a few minor differences
Farronato *et al*., 2014 [45]	Prospective clinical study with 300 participants affected by dental-skeletal facial deformities and edentulism, whose 100 pediatric patients assessed first visit (T1), third stage of the preorthodontic oral prevention scheme (T2), fourth stage of the preorthodontic oral prevention scheme; 100 patients undergoing orthodontic therapy assessed at the first visit (T1), at the positioning of the appliance (T2), at the intermediate stage of the fixed appliance therapy (T3), before removal of the fixed applicance (T4); 75 patients undergoing combined orthodontic-surgical treatment assessed at the first visit (T1), day after surgery (T2), intermaxillary fixation (T3), removal of the fixed appliance (T4); 25 patients undergoing implant-prosthetic rehabilitation assessed at the first visit (T1), before positioning of the implant/s (T2), at the insertion of the crown/s (T3), one month after implant loading (T4)	*Inclusion criteria:* NR *Exclusion criteria:* NR	To describe the qualitative and quantitative changes occurring within the oral bacterial flora of several groups of patients following oral prevention protocols during the stages of the dental treatment they required	*Results:* Mean Plaque Index Score of most patients generally decreased during the various treatment phases and hence the overall bacterial count. However, there was slight increase in the plaque index in patients undergoing orthodontic surgery after placement of the orthodontic appliance and patients undergoing combined orthodontic-surgical treatment during the intermaxillary fixation phase. There was found that the coccoidal bacterial form was the most prevalent *Conclusions*: patients who were adequately instructed and motivated through oral hygiene prevention strategies, showed a significant decrease in the plaque levels and in the overall bacterial components between the first visit and the successive sample taking. The slight increase in the plaque index in patients undergoing the intermaxillary fixation phase decreased immediately once the phase ended, and the patients managed to return to the routine oral hygiene care. This highlights the importance of constant motivation and oral hygiene instruction reinforcement

Abbreviations: CBCT, cone beam computed tomography; BSSRO, bilateral sagittal split osteotomies of the mandible; IAN, inferior alveolar nerve; VAS, Visual Analogue Scale; IVRO, intraoral vertical ramus osteotomy; SSRO, sagittal split ramus osteotomy; HRQoL, health-related quality of life; CAD/CAM, Computer-Aided Design/ Computer-Aided Manufacturing; OQLQ, orthognathic quality of life questionnaire; PSI, patient-specific implants; DOS, digital occlusal splint; DT, digital template; VSP, virtual surgical planning; CSP, conventional surgical planning; Ci-Navi, computer-aided intraoperative navigation; CROS, conventional resin occlusal splint; DOS, digital occlusal splint; DT, digital templates; IMFS, intermaxillary fixation screw; SARME, surgically assisted rapid maxillary expansion; NSAIDs, non-steroidal anti-inflammatory drugs; PTBM, photobiomodulation; GaAlAs, gallium–aluminum–arsenide; EOG, extended osteotomy guide; TOG; traditional osteotomy guide; PPD, pocket probing depth; GR, gingival recession; CAL, clinical attachment level; BOP, bleeding on probing; WKG, width of keratinized gingiva; CHX, chlorhexidine; ADS, anti-discoloration system.

Table S6. NHLBI quality assessment of controlled intervention studies.

NHLBI Quality Assessment of Controlled Intervention Studies																
First Author *et al*., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Total Score**	**Quality Rating**
Chen *et al*., 2015 [15]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	13/14 (92.86%)	Good
Barbosa Cavalcanti *et al*., 2022 [16]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14/14 (100%)	Good
Ruf *et al*., 2004 [17]	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	N	7/14 (50%)	Fair
Bertossi *et al*., 2013 [18]	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	10/14 (71.43%)	Fair
Choi *et al*., 2015 [19]	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	N	7/14 (50%)	Fair
Li *et al*., 2022 [20]	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	12/14 (85.71%)	Good
Mahmoud *et al*., 2022 [21]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	13/14 (92.86%)	Good
Van Hemelen *et al*., 2015 [22]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	12/14 (85.71%)	Good
Chen H. *et al*., 2021 [23]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	13/14 (92.86%)	Good
Li *et al*., 2021 [24]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14/14 (100%)	Good
Schneider *et al*., 2019 [25]	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	N	7/14 (50%)	Fair
Cui *et al*., 2022 [26]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	12/14 (85.71%)	Good
Wang *et al*., 2022 [27]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	12/14 (85.71%)	Good
Chen C. *et al*., 2021 [28]	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	10/14 (71.43%)	Fair
Pelo *et al*., 2017 [29]	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	10/14 (71.43%)	Fair
Bengtsson *et al*., 2018 [30]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	13/14 (92.86%)	Good
Hanafy *et al*., 2019 [31]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14/14 (100%)	Good
Jaeger *et al*., 2020 [32]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	14/14 (100%)	Good
Camacho *et al*., 2020 [33]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	12/14 (85.71%)	Good
de Rezende *et al*., 2018 [34]	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	N	Y	Y	10/14 (71.43%)	Fair
Bevilacqua *et al*., 2016 [35]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	12/14 (85.71%)	Good

Note: Q1: Was the study described as randomized, a randomized trial, a randomized clinical trial, or an RCT?, Q2: Was the method of randomization adequate (*i.e*., use of randomly generated assignment)?, Q3: Was the treatment allocation concealed (so that assignments could not be predicted)?, Q4: Were study participants and providers blinded to treatment group assignment?, Q5: Were the people assessing the outcomes blinded to the participants' group assignments?, Q6: Were the groups similar at baseline on important characteristics that could affect outcomes (*e.g*., demographics, risk factors, co-morbid conditions)?, Q7: Was the overall drop-out rate from the study at endpoint 20% or lower of the number allocated to treatment?, Q8: Was the differential drop-out rate (between treatment groups) at endpoint 15 percentage points or lower?, Q9: Was there high adherence to the intervention protocols for each treatment group?, Q10: Were other interventions avoided or similar in the groups (*e.g*., similar background treatments)?, Q11: Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants?, Q12: Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?, Q13: Were outcomes reported or subgroups analyzed prespecified (*i.e*., identified before analyses were conducted)?, Q14: Were all randomized participants analyzed in the group to which they were originally assigned, *i.e*., did they use an intention-to-treat analysis?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good ≥75%.

Table S7. NHLBI quality assessment for before-after (pre-post) studies with no control group.

NHLBI Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group														
First Author *et al*., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Total Score**	**Quality Rating**
Gruber *et al*., 2005 [36]	Y	N	Y	N	N	Y	Y	N	Y	Y	Y	Y	6/12 (50%)	Fair
Baan *et al*., 2016 [37]	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	10/12 (83.33%)	Good
Badiali *et al*., 2020 [38]	Y	N	Y	N	N	Y	Y	N	Y	Y	Y	N	7/12 (58.33%	Fair

Note: Q1: Was the study question or objective clearly stated?, Q2: Were eligibility/selection criteria for the study population prespecified and clearly described?, Q3: Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?, Q4: Were all eligible participants that met the prespecified entry criteria enrolled?, Q5: Was the sample size sufficiently large to provide confidence in the findings?, Q6: Was the test/service/intervention clearly described and delivered consistently across the study population?, Q7: Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?, Q8: Were the people assessing the outcomes blinded to the participants' exposures/interventions?, Q9: Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?, Q10: Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?, Q11: Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (*i.e.*, did they use an interrupted time-series design)?, Q12: If the intervention was conducted at a group level (*e.g.*, a whole hospital, a community, *etc*.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good ≥75%.

Table S8. NHLBI quality assessment tool for observational cohort and cross-sectional studies.

-	NHLBI Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies															
First Author *et al*., Year	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Total Score**	**Quality Rating**
Cascino *et al*., 2021 [39]	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	N	11/14 (78.57%)	Good
Kee *et al*., 2022 [40]	Y	Y	Y	Y	N	Y	N	Y	Y	N	Y	N	Y	N	9/14 (64.28%)	Fair
Borikanphanitphaisan *et al*., 2021 [41]	Y	Y	Y	Y	N	Y	N	Y	Y	N	Y	N	Y	N	9/14 (64.28%)	Fair
Chen *et al*., 2022 [42]	Y	Y	Y	Y	N	Y	N	Y	Y	N	Y	N	Y	N	9/14 (64.28%)	Fair
Weinspach *et al*., 2012 [43]	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	N	11/14 (78.57%)	Good
Haffajee *et al*., 2008 [44]	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	N	11/14 (78.57%)	Good
Farronato *et al*., 2014 [45]	Y	Y	Y	N	N	Y	N	Y	Y	N	Y	N	Y	N	8/14 (57.14%)	Fair

Note: Q1: Was the research question or objective in this paper clearly stated?, Q2: Was the study population clearly specified and defined?, Q3: Was the participation rate of eligible persons at least 50%?, Q4: Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?, Q5: Was a sample size justification, power description, or variance and effect estimates provided?, Q6: For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?, Q7: Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?, Q8: For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (*e.g.*, categories of exposure, or exposure measured as continuous variable)?, Q9: Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?, Q10: Was the exposure(s) assessed more than once over time?, Q11: Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?, Q12: Were the outcome assessors blinded to the exposure status of participants?, Q13: Was loss to follow-up after baseline 20% or less?, Q14: Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?; Total Score: Number of yes; CD: cannot be determined; NA: not applicable; NR: not reported; N: no; Y: yes. Quality Rating: Poor <50%, Fair 50–75%, Good ≥75%.

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