AJO-DO

Effect of conventional combined orthodontic-surgical treatment on oral health-related quality of life: A systematic review and meta-analysis

Jianru Yi, Wenxin Lu, Jiani Xiao, Xiaobing Li, Yu Li, and Zhihe Zhao
Chengdu, People's Republic of China

Introduction: Although conventional combined orthodontic-surgical treatment is frequently applied in orthodontic clinic practice, its actual effect on oral health–related quality of life (OHRQoL) remains inconclusive. We aimed to appraise trials investigating the effect of conventional combined orthodontic-surgical treatment on OHRQoL in patients with dentofacial deformities. **Methods:** Electronic searches of 6 databases and manual searches were conducted up to January 2019. Randomized controlled trials, controlled clinical trials, and prospective cohort studies that investigated the impact of combined orthodontic-surgical treatment on OHRQoL using validated instruments were included. The risk of bias within individual studies was assessed with the use of the Cochrane tool or the Newcastle-Ottawa Scale according to study designs. Meta-analysis was conducted, and OHRQoL at different time points during conventional combined orthodontic-surgical treatment were statistically pooled and compared. **Results:** Of the 893 records initially identified, 24 studies were included in this review. Relative to pretreatment, the condition-specific OHRQoL was significantly improved 6 months after surgery, particularly in the perceptions to social aspects (mean difference [MD] 4.88, 95% confidence interval [CI] 2.45 to 7.32), facial appearance (MD 5.48, 95% CI 4.18 to 6.79), and oral function (MD 4.49, 95% CI 3.27 to 5.72). In terms of changes during combined orthodontic-surgical treatment, the condition-specific OHRQoL worsened in the presurgical orthodontic treatment (MD −7.25, 95% CI −13.29 to −1.22) and improved postsurgically compared with pretreatment (MD 16.59, 95% CI 10.41 to 22.77). Similar patterns were observed in the general OHRQoL changes. **Conclusions:** For patients undergoing combined orthodontic-surgical treatment, the OHRQoL seems to decrease temporarily in presurgical orthodontic treatment compared with pretreatment and to increase to a level better than it was before treatment during postsurgical orthodontic treatment. Based on the present review, combined orthodontic-surgical treatment could be an effective choice to improve OHRQoL for patients affected with severe dentofacial deformities. (Am J Orthod Dentofacial Orthop 2019;156:29-43)

The impact of malocclusion on oral function, esthetics concern, and psychologic status of patients has been long recognized.[1,2] Although orthodontic treatment is effective to solve these problems for most patients,[3] it has been estimated that ∼5% of the U.K. and U.S. populations are affected with severe dentofacial deformities that can not be corrected by orthodontic treatment alone.[4,5] For these individuals, combined orthodontic-surgical treatment is often required to obtain stable occlusion and ideal facial profile.[6]

In current clinic practice, combined orthodontic-surgical treatment mainly consists of 2 modalities: the conventional combined orthodontic-surgical treatment (COST) and the surgery-first approach.[7] COST includes 3 phases: presurgical orthodontic treatment, orthognathic surgery, and postsurgical orthodontic treatment.[8]

Department of Orthodontic and Pediatric Dentistry, State Key Laboratory of Oral Diseases, National Clinical Research Center for Oral Diseases, West China Hospital of Stomatology, Sichuan University, Chengdu, People's Republic of China.
All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and none were reported.
Registration: PROSPERO CRD42017070656.
Funding: National Natural Science Foundation of China (grant 81801018) and Orthodontic National Key Clinical Specialty Program of China, West China Hospital of Stomatology, Sichuan University.
Address correspondence to: Zhihe Zhao, Vice Dean, Department of Orthodontic and Pediatric Dentistry, State Key Laboratory of Oral Diseases, National Clinical Research Center for Oral Diseases, West China Hospital of Stomatology, Sichuan University, #14, 3rd Section, South Renmin Road, Chengdu 610041, PR China; e-mail, zhzhao@scu.edu.cn.
Submitted, December 2018; revised and accepted, March 2019.
0889-5406/$36.00

https://doi.org/10.1016/j.ajodo.2019.03.008

The long duration and high expenses of COST, together with the trauma and interference to daily life caused by surgery, could make patients uncertain whether it is worth receiving COST and impair their determinations to seek treatment.[9] Although the surgery-first approach was recently developed,[10] its clinical application is rather limited compared with COST owing to the strict indications,[11] questionable treatment stability,[12] and high risk of complications.[13] Therefore, based on the current circumstance, it is critical to investigate whether COST could improve the quality of life in patients suffering from dentofacial deformities.

The quality of life associated with oral health is termed oral health–related quality of life (OHRQoL).[14] COST is empirically thought to improve OHRQoL by correcting dentofacial deformities and improving facial appearance with resulting benefits in psychologic and social aspects.[15] However, among the 3 distinct stages of COST, either the temporarily worsened occlusion and facial profile in the presurgical period or the orthognathic surgery per se may negatively influence OHRQoL.[7,16] Therefore the actual impacts of COST on OHRQoL have always attracted much attention. In the past decade, several clinical trials have investigated the changes of OHRQoL in patients undergoing COST. Unfortunately, the heterogeneity of methodology and conflicting results in these studies could bias the evidence and produce difficulties for clinicians and patients to make decisions.

To further validate the changes in OHRQoL of patients subjected to COST, a systematic review and meta-analysis are needed. Thus, the purpose of the present study was to systematically review the current literature to evaluate the impact of COST on patients' OHRQoL.

MATERIAL AND METHODS

Protocol and registration

The present systematic review and meta-analysis was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta analyses (PRISMA) guidelines.[17] The protocol for this study was registered on the International Prospective Register of Systematic Reviews (PROSPERO) under the ID CRD42017070656.

Eligibility criteria

The studies included in this review should help to define the question "In patients with dentofacial deformities that are not receptive to orthodontic treatment alone, is COST able to improve OHRQoL?" according to the PICOS strategy as follows: Participants: patients affected by dentofacial deformities that required COST, age at least 16 years; Intervention: the use of COST to correct dentofacial deformities; Comparison: studies should include either the evaluation of OHRQoL before and after orthognathic surgery or a group of subjects who had no plan for COST; specifically, the comparator is the patients who need COST but either had not begun to receive the presurgical treatment or orthognathic surgery yet or they would not receive the treatment during the whole clinical trial; Outcomes: the primary outcome was the OHRQoL assessed at any time during the whole course of COST and the follow-ups after COST; the secondary outcome was the individual dimensions of OHRQoL evaluation; Study designs: randomized controlled trials (RCTs), controlled clinical trials (CCTs), and prospective cohort studies.

The exclusion criteria were as follows: (1) retrospective cohort studies, cross-sectional studies, and case reports; (2) invalidated measure instruments; (3) individuals younger than 16 years involved; and (4) participants diagnosed with cleft lip and palate or deformities caused by trauma or any systemic diseases.

Information sources, search strategy and study selection

The electronic search was performed in databases including PubMed, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), China National Knowledge Infrastructure (CNKI), ProQuest Dissertation and Theses, and System for Information on Grey Literature in Europe (SIGLE). The search strategy in PubMed was a combination of Medical Subject Headings (MeSH) terms with free-text words, and optimized for each database respectively. The search strategies are summarized in Supplementary Table 1 (Supplementary Tables I-IV are available at www.ajodo.org). The electronic search was conducted in May 2018 and updated in January 2019 without restriction on language and publication date. In addition, relevant journals and the reference of retrieved studies were manually checked and reviewed to identify additional eligible studies.

The retrieved records were evaluated for eligibility according to inclusion and exclusion criteria by 2 review authors independently. Any disagreement was resolved by discussing with a third review author for consensus.

Data extraction and data items

Two reviewers independently extracted the data of included studies with the use of a standardized piloted data collection form. Disagreements between the 2 reviewers were resolved by discussing with a third reviewer. Based on the purpose of this review, the information regarding the first author, publication year, study design, demographic data, dentofacial deformities, surgical approaches, measure of OHRQoL, and follow-ups were collected.

Risk of bias in individual studies

The risk of bias of the recruited RCTs was evaluated with the use of the Cochrane Collaboration's risk of bias tool.[18] When nonrandomized clinical trials were included, the Newcastle-Ottawa Scale (NOS) was adopted.[19] The NOS assessed the quality of studies on the basis of 3 broad perspectives: participant selection (4 items), comparability (1 item), and outcome (3 items). The studies would be awarded 1 star for each item in the section of participant selection and outcome, and 2 stars at most for comparability. Studies scored at 9 stars, 6-8 stars, and <6 stars would be assessed as having low, moderate, and high risk of bias, respectively.

Summary measure

The effect estimates of interventions in the included studies were expressed as mean difference and standard deviation for continuous outcomes and as odds ratio and 95% confidence interval (CI) for dichotomous outcomes.

Synthesis of results and additional analyses

The data that could not be subjected to meta-analysis were qualitatively analyzed and summarized. Quantitative data of OHRQoL were statistically combined to calculate the pooled mean values for meta-analysis. The heterogeneity of included studies was assessed with the use of the I^2 statistic. The data were analyzed with the use of a random-effects model when substantial heterogeneity (I^2 >50%) was found. Otherwise, a fixed effects model was adopted. A statistical test with a P value <0.05 was set as significant (Z-test). Sensitivity analysis was used to explore the heterogeneity source, assess the potential influence of missing data, and test the stability of the main outcomes. Funnel plots were generated to test the publication bias if the sum of included studies in an outcome exceeded 10.[20] All analyses were conducted with the use of the RevMan software (version 5.3; Nordic Cochrane Center, Cochrane Collaboration, Copenhagen, Denmark).

RESULTS

Study selection

A total of 893 records were identified through electronic and manual search after the removal of duplicates, and 841 publications were excluded by screening the title and abstract. After that, the full texts of the remaining articles were obtained and evaluated according to the eligibility criteria, among which 24 records were assessed as qualified and included in the present systematic review.[21-44] The details of the literature search and study selection are summarized in the flowchart diagram in Figure 1. The excluded studies with reasons are listed in Supplementary Table II.

Study characteristics

Details of the included studies are summarized in Table I. Among the 24 studies, 23[21-43] were prospective cohort studies and the other was an RCT.[44] A total of 965 participants were enrolled in this review, with the sample size of individual studies ranging from 8 to 110. Of these studies, patients with Class II and Class III malocclusion were recruited exclusively in 1 and 5 studies, respectively. Eleven studies included participants with different malocclusions, and the other 7 studies did not report related information (Table I).

Regarding orthognathic surgical approaches, 12 studies used bilateral sagittal-split ramus osteotomy (BSSRO) and 9 used Le Fort I osteotomy, 7 of which adopted a combination of these 2 techniques. Seven studies simply described the surgery as single-jaw or bimaxillary, and the other 3 studies had no detailed information of surgical approaches (Table I).

Two types of OHRQoL questionnaires were involved in the included studies. Sixteen studies adopted a generic instrument called the Oral Health Impact Profile (OHIP) questionnaire, among which 14 used OHIP-14, 1 used OHIP-49, and the other used OHIP-54. Fifteen studies used the Orthognathic Quality of Life Questionnaire (OQLQ-22), which is a condition-specific questionnaire designed to assess the OHRQoL of patients undergoing orthognathic treatment. Seven studies used both the OQLQ-22 and the OHIP-14 for evaluation (Table I).

To evaluate the changes of OHRQoL, 9 studies performed the assessment twice, and the other 15 evaluated the OHRQoL more than twice during the whole trial. The most frequently used timings for OHRQoL evaluation were before treatment, before surgery, 1-2 months after surgery, and ∼6 months after surgery (Table I).

Risk of bias in individual studies

The NOS scores of the included 23 cohort studies ranged from 5 to 8, with an average score of 6.26. Nineteen of these studies[25-43] were judged to have moderate risk of bias, and the other 4[21-24] were found to have high risk of bias (Supplementary Table III). Regarding the included RCT,[44] the details of the blinding and other sources of bias were unclear, and the study was assessed to have an unclear risk of bias (Supplementary Table IV).

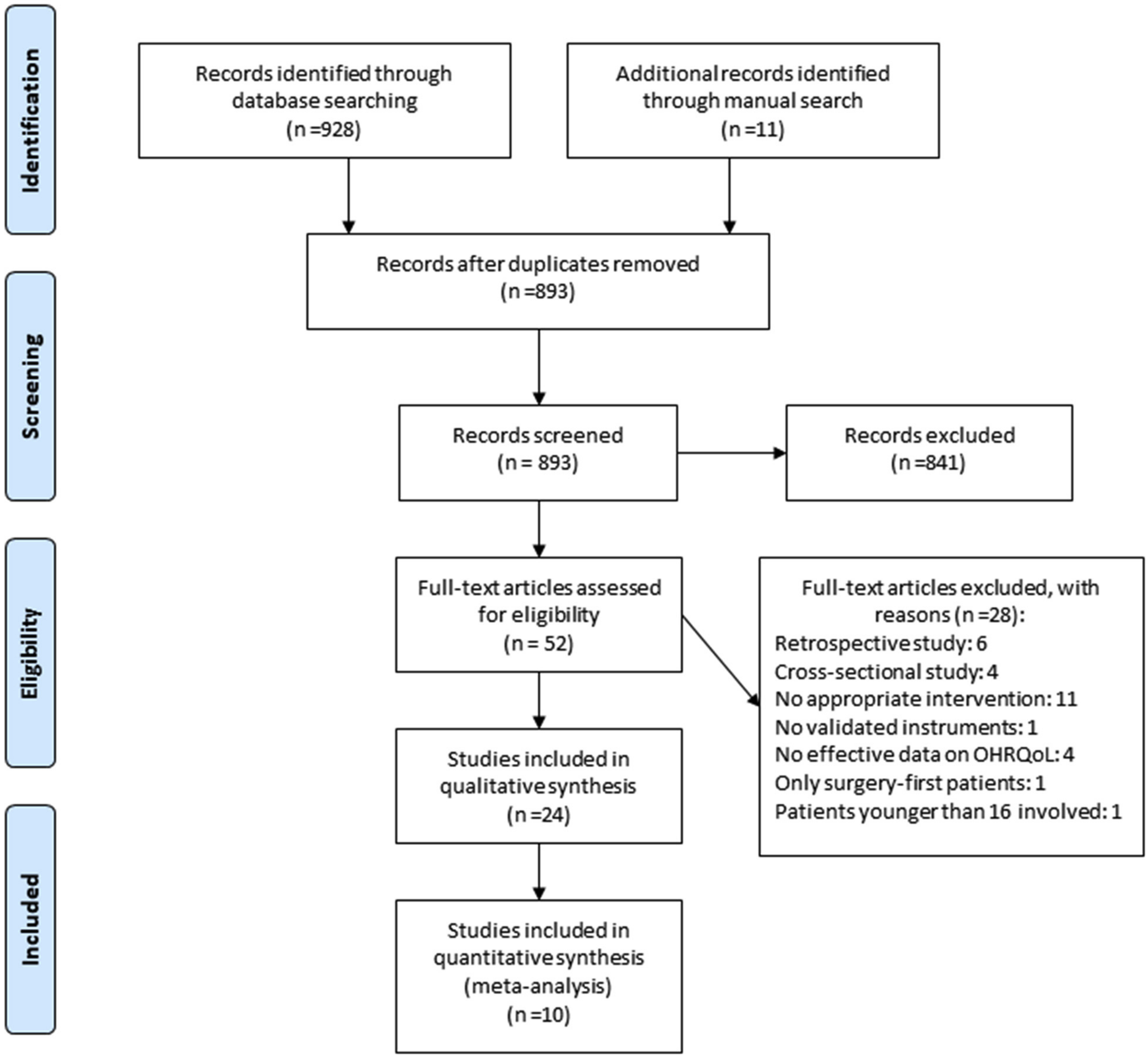


Fig 1. PRISMA flow diagram of study selection.

Synthesis of results and additional analyses

Based on the timings for OHRQoL assessment among the studies included in quantitative synthesis, we classified the data into 4 categories: before treatment, before surgery, 1-2 months after surgery, and 6 months after surgery. We compared the OHRQoLs assessed at different times to investigate the changes of OHRQoL after complete COST and the changes during the 3 distinct stages of treatment.

Of the studies included in quantitative analyses, 2 questionnaires—OQLQ-22 and OHIP14—were involved. OQLQ-22 and OHIP-14 focus on condition-specific and general OHRQoL, respectively. We defined the condition-specific OHRQoL (total score of OQLQ-22) as the main outcome because the content of OQLQ-22 is closely associated with the concerns of the population involved in this study. We statistically synthesized the total scores and individual domains of OQLQ-22 and the total scores of OHIP-14 (general OHRQoL). Sensitivity analysis was performed regarding the total scores of OQLQ-22 to explore the heterogeneity source and the potential influence of missing data in 4 included studies.[27,36,39,40]

Before treatment to before surgery

The meta-analysis showed that the overall score of OQLQ-22 before surgery was significantly higher than

Table I. Overview of included studies

Study	*Design*	*Origin*	*Participants*	*Malocclusion*	*Method of fixation*	*OHRQoL measure*	*Type of orthognathic surgery*	*Assessment timing*	*Conclusion*
Azuma 2008	Cohort study	Japan	31: F 25, M 6; Age: 25.4 y (17.3-42.5 y)	Not stated	Not stated	OQLQ-22	Single-jaw or bimaxillary surgery	T0: before surgery; T1: after treatment	OHRQoL and anxiety of patients were improved after surgical correction
Lee 2008	Cohort study	China	36: F 25, M 11; Age: 23.25 ± 6.6 y	Class II, Class III	Not stated	OQLQ-22, OHIP-14	Bimaxillary surgery	T0: before surgery; T1/T2: 6 wk/6 mo after surgery	OHRQoL decreased transiently after surgery and then increased significantly compared with before surgery
Choi 2010	Cohort study	China	32: F 22, M 10; Age: 23.9 ± 6.7 y	Class I, Class II	Not stated	OQLQ-22, OHIP-14	Bimaxillary surgery	T0: before treatment; T1/T2: 6 wk/6 mo after surgery; T3: 6 mo after treatment	Significant improvement in OHRQoL occurred after treatment
Khadka 2011	Cohort study	China	110: F 77, M 33; Age: 22.9 y	Class II, Class III	Not stated	OQLQ-22	Sagittal split osteotomy; Le Fort I osteotomy; anterior subapical segmental osteotomy	T0: before surgery; T1: 6-8 mo after surgery	Improvement in QoL after orthognathic surgery was evident compared with before surgery
Murphy 2011	Cohort study	Ireland	52: F 30, M 22; Age: 21.6 y (18-38 y)	Class I, Class II, Class III	Not stated	OQLQ-22	Mandibular setback; bimaxillary surgery	T0: before surgery; T1: 6 mo after surgery	The total score and each individual dimension of OHRQoL were improved
Kavin 2012	Cohort study	India	14; Age: 26 y (22-34 y)	Class II	Not stated	OHIP-14, OQLQ-22	Anterior maxillary osteotomy	T0: before surgery; T1/T2: 8/24 wk after surgery	Surgery had a positive impact on OHRQoL
Rustemeyer 2012	Cohort study	Germany	50: F 30, M 20; Age: 26.9 ± 9.9 y	Class II, Class III	Rigid internal fixation	OHIP-14	Le Fort I osteotomy; BSSRO	T0: before treatment; T1: 12 mo after surgery	Both functional and psychosocial benefits were experienced after COST
Goelzer 2014	Cohort study	Brazil	74: F 49, M 25; Age: 28.0 ± 9.0 y	Class I, Class II, Class III	Not stated	OHIP-14	Single-jaw or bimaxillary surgery	T0: before surgery; T1: 4-6 mo after surgery	OHRQoL was increased after COST; Class II and III patients reported significant improvement in more domains than Class I patients

Table I. Continued

Study	Design	Origin	Participants	Malocclusion	Method of fixation	OHRQoL measure	Type of orthognathic surgery	Assessment timing	Conclusion
Baherimoghaddam 2015	Cohort study	Iran	58: F 27, M 31; Age: 23.2 y	Class II, Class III	Rigid internal fixation	OHIP-14	Le Fort I osteotomy; BSSRO	T0: before treatment; T1: before surgery; T2: 6 mo after surgery; T3: 12 mo after treatment	Class II: OHRQoL decreased in presurgical period and increased after surgery. Class III: OHRQoL increased slightly in presurgical period and increased significantly after surgery
Abdullah 2015	Cohort study	Saudi Arabia	17: F 12, M 5; Age: 19-37 y	Not stated	Not stated	OQLQ-22	BSSRO; bimaxillary osteotomy	T0: before surgery; T1: 1 y after surgery	The overall and each domain of OHRQoL were improved after surgery
Kurabe 2016	Cohort study	Japan	65: F 44, M:21; Age: 23.6 ± 8.1 y	Class I, Class II, Class III	Miniplates; resorbable devices	OHIP-J54	Le Fort I osteotomy; BSSRO	T0: before surgery; T1: 6 mo after surgery	OHRQoL of patients was significantly improved after surgery
Silva 2016	Cohort study	Sweden	50: F 28, M 22; Age: 22.7 y (18-66 y)	Not stated	Not stated	OQLQ-22, OHIP-14	Le Fort I osteotomy; BSSRO	T0: before surgery; T1: 6 wk after surgery; T2: 6 mo after surgery	The improvement in OHRQoL was not evident at 6 wk after surgery and became significant at 6 mo after surgery
Huang 2016	Cohort study	China	25: F 13, M 12; Age: 24.2 ± 4.2 y	Class III	Not stated	OHIP-14	BSSRO	T0: before treatment; T1-T3: 6/12/18 mo after treatment initiation; T4: after treatment	OHRQoL was enhanced by COST
Corso 2016	Cohort study	Brazil	30: F 24, M 6; Age: 29.4 ± 9.3 y	Not stated	Not stated	OHIP-14	Not stated	T0: before surgery; T1: 1 mo after surgery; T2: 3 mo after surgery	Quality of life improved considerably in patients 3 mo after the operation

Table I. Continued

Study	*Design*	*Origin*	*Participants*	*Malocclusion*	*Method of fixation*	*OHRQoL measure*	*Type of orthognathic surgery*	*Assessment timing*	*Conclusion*
Alanko 2017	Cohort study	Finland	22: F 16, M 6; Age: 36 y (18-54 y)	Not stated	Not stated	OQLQ-22	BSSRO; bimaxillary surgery; maxillary surgery	T0: before treatment; T1: after the first orthodontic examination; T2: 6-8 wk after appliance placement; T3: before surgery; T4: 6 wk after surgery; T5: 1 y after surgery	Psychosocial well-being was decreased during the presurgical period and increased to a level that was similar to the control group after surgery
Feu 2017	Cohort study	Brazil	8: F 5, M 3; Age: 26.8 ± 7.1 y	Class III	Not stated	OQLQ-22, OHIP-14	Bimaxillary surgery	T0: before treatment; T1-T5: 1/3/6/12/24 mo after treatment initiation	OHRQoL was worsened insignificantly in the presurgical phase and increased significantly after surgery compared with before treatment
Wang 2017	Cohort study	China	25: F 13, M 12; Age: 25.1 ± 6.8 y	Class III	Rigid internal fixation	OHIP-14	BSSRO	T0: before treatment; T2-T4: 1/6/12 mo after treatment initiation; T5: after treatment	OHRQoL was decreased at 6 mo after treatment initiation and increased significantly after treatment compared with before treatment
Pelo 2017	Cohort study	Italy	15; Age: 30.2 ± 6.4 y	Class II, Class III	Not stated	OQLQ-22, OHIP-14	Le Fort I osteotomy; BSSRO	T0: before treatment; T1: before surgery; T2: 1 mo after surgery	OHRQoL worsened during orthodontic treatment, followed by postoperative improvement
Eslamipour 2017	Cohort study	Iran	43: F 30, M 13; Age: 18-40 y	Class II, Class III	Not stated	OQLQ-22	Bimaxillary osteotomy	T0: before surgery; T1: 3 wk after surgery; T2/T3: 3/6 mo after surgery	Significant improvements in OHRQoL, as assessed in emotional, psychologic, oral function, and social domains, occurred after surgery

Table I. Continued

Study	*Design*	*Origin*	*Participants*	*Malocclusion*	*Method of fixation*	*OHRQoL measure*	*Type of orthognathic surgery*	*Assessment timing*	*Conclusion*
Razvadi 2017	Cohort study	Iran	24: F 15, M 9; Age: 22.6 ± 3.6 y	Not stated	Not stated	OQLQ-22	Not stated	T0: 1 wk before surgery; T1: 4 wk after surgery; T2: 4 mo after surgery	OHRQoL increased significantly at 4 mo after surgery compared with 1 wk before surgery
Nichols 2018	Cohort study	New Zealand	22: F 9, M 13; Age: 19.3 ± 4.7 y	Not stated	Not stated	OHIP-14	Not stated	T0: before treatment; T1: after treatment; T2: ∼5 y after treatment	OHRQoL increased significantly after treatment and decreased slightly ∼5 y after treatment
Bengtsson	RCT	Sweden	57: F 27, M 30; Age: 20.8 y (18-28 y)	Class III	Not stated	OHIP-49	Le Fort I osteotomy; BSSRO; vertical ramus mandibular osteotomy; genioplasty	T0: before surgery; T1: 12 mo after surgery	Improvements in OHRQoL were shown after treatment
Sun 2018	Cohort study	China	85: F 54, M 31; Age: 24.0 y (17-41 y)	Class I, Class II, Class III	Not stated	OQLQ-22, OHIP-14	Le Fort I osteotomy; BSSRO	T0: before surgery; T1: 5-7 mo after surgery	OHRQoL was positively influenced by surgery. Class III patients who received double jaw surgery benefited the most after surgery
Tachiki 2018	Cohort study	Japan	20: F 10, M 10; Age: 23.2 ± 7.3 y	Class III	Semirigid fixation	OQLQ-22	Le Fort I osteotomy; BSSRO	T0: before treatment; T1: before surgery; T2: 6 mo after surgery	OHRQoL was transiently worsened during presurgical treatment and then increased significantly after surgery

BSSRO, bilateral sagittal-split ramus osteotomy; *OHIP,* Oral Health Impact Profile; *OHRQoL,* oral health–related quality of life; *OQLQ,* Orthognathic Quality of Life Questionnaire; *before treatment,* before the placement of fixed appliance; *after treatment,* after the removal of fixed orthodontic appliance.

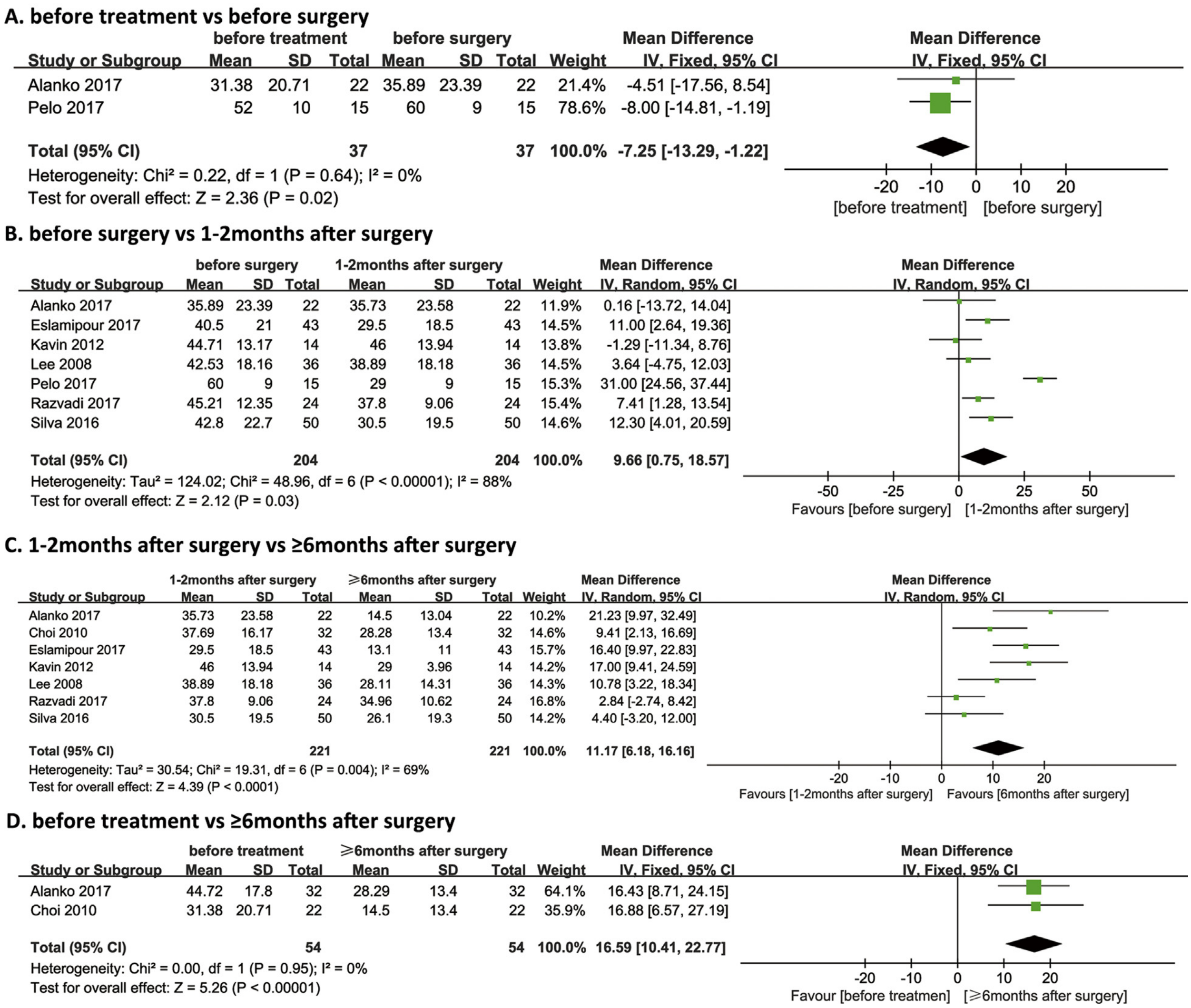


Fig 2. Forest plot for the total scores of OQLQ-22: **A,** before treatment vs before surgery; **B,** before surgery vs 1-2 months after surgery; **C,** 1-2 months after surgery vs ≥6 months after surgery; **D,** before treatment vs ≥6 months after surgery.

that before treatment, with MD −7.25 (95% CI −13.29 to −1.22; Fig 2, *A*), indicating the reduction of OHRQoL during the presurgical orthodontic treatment. Regarding the individual dimensions, reduction of OHRQoL were detected in the domains of facial esthetics (MD −1.53, 95% CI −3.02 to −0.04) and oral function (MD-2.24, 95% CI −4.00 to −0.49), whereas no difference was found in the domains social aspects (MD-2.00, 95% CI −5.79 to 1.80) and awareness (MD −0.46, 95% CI −2.11 to 1.19; Fig 3). The evaluation by OHIP-14 also demonstrated that OHRQoL before surgery was lower than before treatment (MD −5.00, 95% CI −8.95 to −1.05) (Supplementary Fig 1, *A*; available at www.ajodo.org). No significant change was detected in sensitivity analysis (data not presented).

Before surgery to 1-2 months after surgery

The total scores (MD 9.66, 95% CI 0.75 to 18.57) and domains of social aspects (MD 3.59, 95% CI 0.70 to 6.49) and facial esthetics (MD 4.38, 95% CI 1.64 to 7.12) measured by OQLQ-22 at 1-2 months after surgery were lower than the results before surgery (Figs. 2, *B*, and 4), indicating improvement of OHRQoL. No significant difference was observed in the domains of oral function (MD −1.07, 95% CI −3.99 to 1.84) and awareness (MD 0.72, 95% CI −0.40 to 1.84; Fig 4). The OHIP-14 scores were similar between these 2 timings (MD 3.51, 95% CI −4.80 to 11.82; Supplementary Fig 1, *B*).

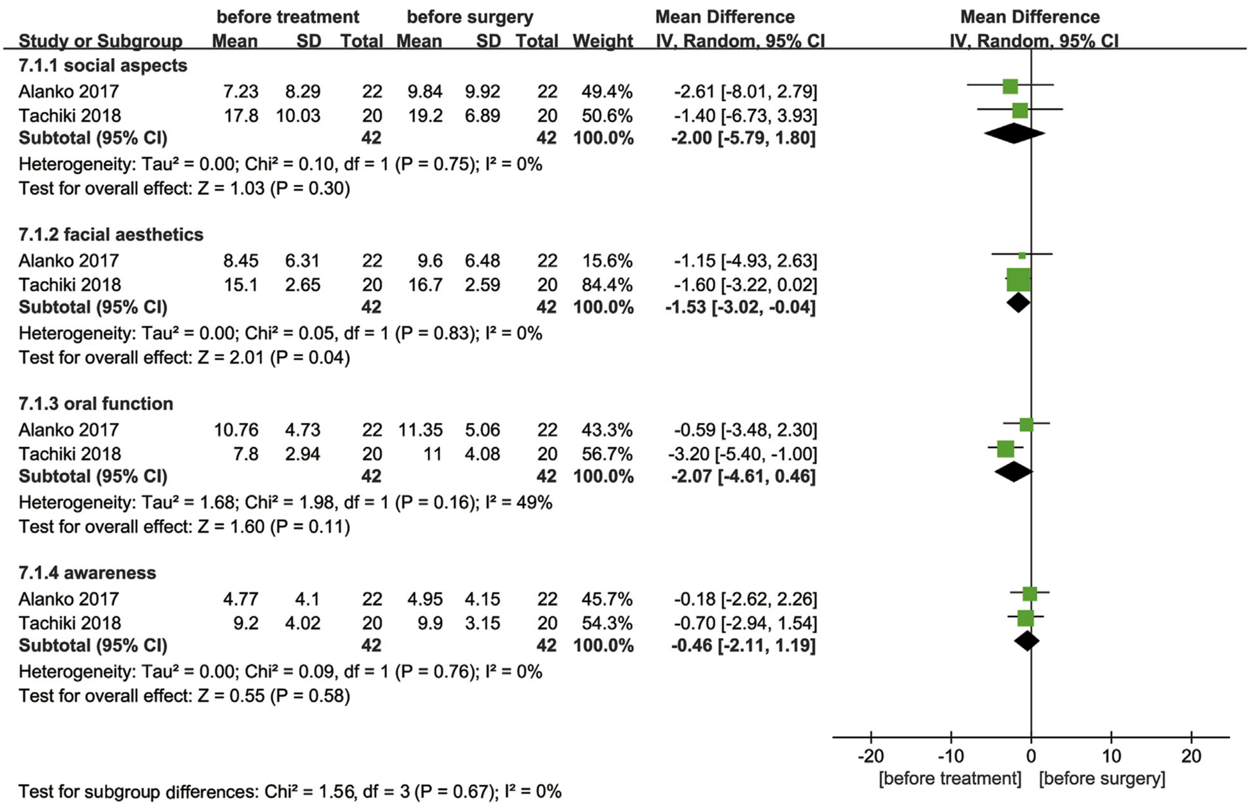


Fig 3. Forest plot for the comparison of individual dimensions in OQLQ-22 before treatment vs before surgery.

Significant changes were found when omitting 3 studies individually, and a substantial reduction of heterogeneity from 88% to 24% was observed when excluding 1 study (Table II).

1-2 months after surgery to ≥6 months after surgery

When comparing the results evaluated at ≥6 months after surgery with 1-2 months after surgery, the improvements of OHRQoL were found in the total scores (MD 11.17, 95% CI 6.18 to 16.16; Fig 2, *C*) and each individual domain of OQLQ-22 (Fig 5). Similar results were observed in the measurement by OHIP-14 (MD 7.38, 95% CI 3.70 to 11.06; Supplementary Fig 1, *C*). The exclusion of each individual study did not result in any significant difference to the overall estimates and heterogeneity (data not shown).

Before treatment to ≥6 months after surgery

To investigate the effect of complete treatment on OHRQoL, we compared the results assessed before treatment and ≥6 months after surgery. The pooled results measured by OQLQ-22, including the total scores (MD 16.59, 95% CI 10.41 to 22.77; Fig 2, *D*), and the domains of social aspects (MD 4.88, 95% CI 2.45 to 7.32), facial esthetics (MD 5.48, 95% CI 4.18 to 6.79), and oral function (MD 4.49, 95% CI 3.27 to 5.72) were significantly reduced (Fig 6), indicating the improvement of OHRQoL. No statistical difference was detected in the awareness domain (MD 0.96, 95% CI −0.29 to 2.21; Fig 6). The OHIP-14 result also showed the OHRQoL to be improved at 6 months after surgery (MD 9.85, 95% CI 8.20 to 11.49; Supplementary Fig 1, *D*). The sensitivity analysis regarding the total OQLQ-22 scores by omitting each individual study in turn failed to found any significant change (data not presented).

All of the 14 studies that were not included in the quantitative analysis reported an improvement of OHRQoL at postsurgical orthodontic treatment or after complete COST.

DISCUSSION

Summary of evidence

COST has become a widely accepted approach for the severe dentofacial deformities that orthodontic treatment alone is insufficient to correct since 1970s.[6,8] A recent narrative review suggested that the effect of

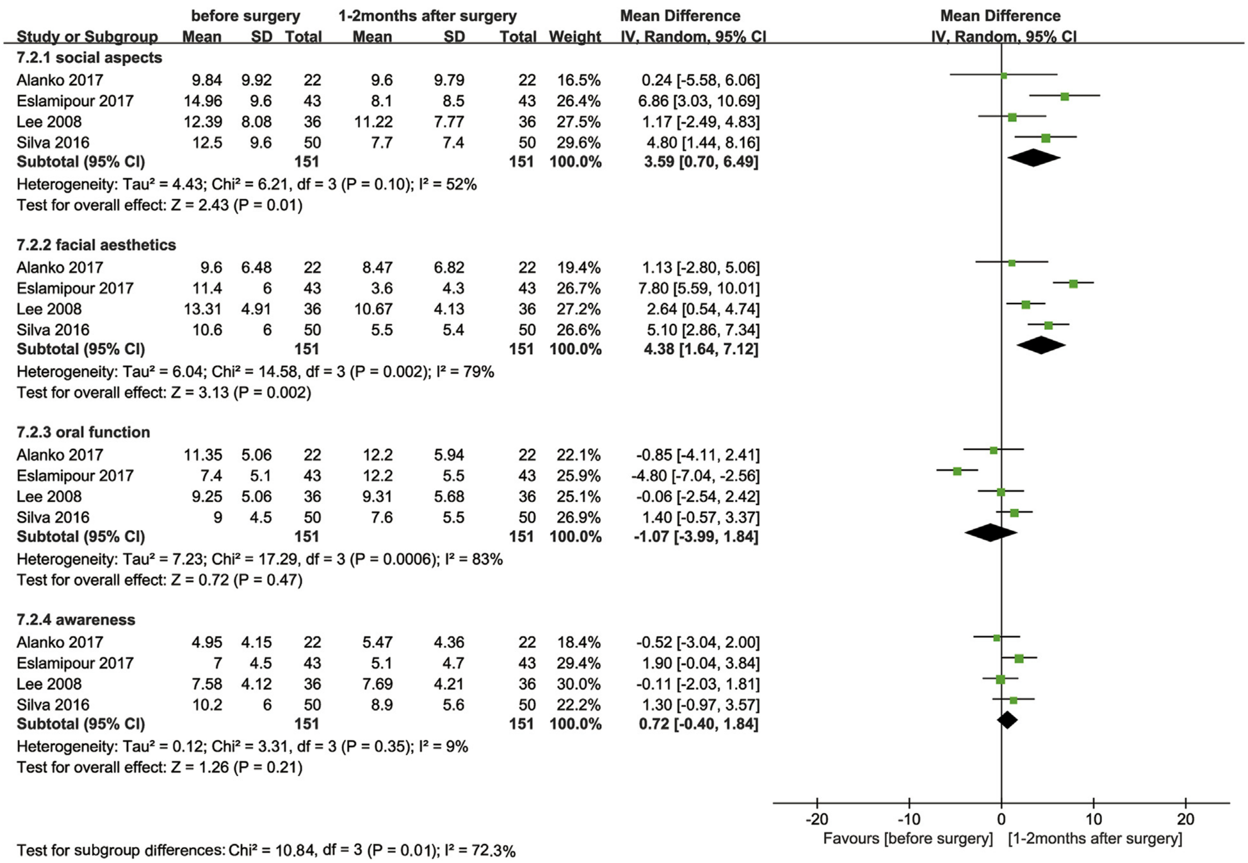


Fig 4. Forest plot for the comparison of individual dimensions in OQLQ-22 before surgery vs 1-2 months after surgery.

Table II. Summary of the significant changes in sensitivity analyses

Studies omitted	*Number of studies*	*Sample size*	I^2	*MD*	*95% CI*
Original estimates	7	204	88%	9.66	0.75 to 18.57
Eslampiour et al	6	161	90%	9.34	−1.19 to 19.87*
Pelo et al	6	189	24%*	6.55	2.51 to 10.60
Razvadi et al	6	180	89%	9.95	−0.91 to 20.80*
Silva et al	6	154	90%	9.12	−1.43 to 19.67*

MD, mean difference; *CI,* confidence interval.
*Significant change when the study is omitted.

COST on quality of life is affected by several factors.[45] However, the actual impacts of COST on patients' OHRQoL have remained unclear. The present study, as far as we know, is the first to address this issue by means of an evidence-based method.

The timings for OHRQoL assessment in the included studies varied significantly. Only 2 studies,[21,24] which were determined to have high risk of bias, evaluated the OHRQoL of participants at both placement and removal of orthodontic appliances, and determining the effect of a complete COST by quantitatively comparing the data at these 2 timings seemed to be unreliable. To better investigate the changes of patients' OHRQoL during treatment, we classified the quantitative data into 4 categories according to the timing of assessment: before treatment, before surgery, 1-2 months after surgery, and ≥6 months after surgery. The comparison between the results before treatment and ≥6 months after surgery could be considered as the effect of complete COST because previous studies found the average duration of postsurgical treatment to be slightly more than 6 months,[46,47] and the intervals between each 2 neighboring timings are roughly equal to the 3 stages of COST. According to the quantitative analysis

	1-2months after surgery			≥6months after surgery				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
7.3.1 social aspects								
Alanko 2017	9.6	9.79	22	2.86	5.29	22	10.4%	6.74 [2.09, 11.39]
Choi 2010	11.03	6.67	32	8.65	4.68	32	23.4%	2.38 [-0.44, 5.20]
Eslamipour 2017	8.1	8.5	43	4.1	4	43	23.6%	4.00 [1.19, 6.81]
Lee 2008	11.22	7.77	36	8.08	6.47	36	18.4%	3.14 [-0.16, 6.44]
Silva 2016	7.7	7.4	50	6.7	6.6	50	24.3%	1.00 [-1.75, 3.75]
Subtotal (95% CI)			**183**			**183**	**100.0%**	**3.02 [1.42, 4.61]**
Heterogeneity: Tau² = 0.76; Chi² = 5.19, df = 4 (P = 0.27); I² = 23%								
Test for overall effect: Z = 3.71 (P = 0.0002)								
7.3.2 facial aesthetics								
Alanko 2017	8.47	6.82	22	4.23	4.39	22	6.7%	4.24 [0.85, 7.63]
Choi 2010	9.94	4	32	7.74	3.75	32	21.3%	2.20 [0.30, 4.10]
Eslamipour 2017	3.6	4.3	43	2	2.9	43	31.9%	1.60 [0.05, 3.15]
Lee 2008	10.67	4.13	36	8.36	4.02	36	21.7%	2.31 [0.43, 4.19]
Silva 2016	5.5	5.4	50	4.8	5	50	18.4%	0.70 [-1.34, 2.74]
Subtotal (95% CI)			**183**			**183**	**100.0%**	**1.89 [1.02, 2.77]**
Heterogeneity: Tau² = 0.00; Chi² = 3.58, df = 4 (P = 0.47); I² = 0%								
Test for overall effect: Z = 4.23 (P < 0.0001)								
7.3.3 oral function								
Alanko 2017	12.2	5.94	22	5	3.55	22	17.4%	7.20 [4.31, 10.09]
Choi 2010	9.06	5.65	32	5	3.76	32	19.7%	4.06 [1.71, 6.41]
Eslamipour 2017	12.2	5.5	43	4.4	4.1	43	21.1%	7.80 [5.75, 9.85]
Lee 2008	9.31	5.68	36	4.94	3.41	36	20.6%	4.37 [2.21, 6.53]
Silva 2016	7.6	5.5	50	5.1	4.7	50	21.3%	2.50 [0.49, 4.51]
Subtotal (95% CI)			**183**			**183**	**100.0%**	**5.13 [3.09, 7.17]**
Heterogeneity: Tau² = 4.05; Chi² = 16.30, df = 4 (P = 0.003); I² = 75%								
Test for overall effect: Z = 4.92 (P < 0.00001)								
7.3.4 awareness								
Alanko 2017	5.47	4.36	22	2.41	3.19	22	18.7%	3.06 [0.80, 5.32]
Choi 2010	8.9	5.6	32	8.8	5.9	32	13.6%	0.10 [-2.72, 2.92]
Eslamipour 2017	5.1	4.7	43	2.5	2.9	43	27.3%	2.60 [0.95, 4.25]
Lee 2008	7.69	4.21	36	6.72	4.53	36	21.6%	0.97 [-1.05, 2.99]
Silva 2016	8.9	5.6	50	8.8	5.9	50	18.8%	0.10 [-2.15, 2.35]
Subtotal (95% CI)			**183**			**183**	**100.0%**	**1.52 [0.33, 2.72]**
Heterogeneity: Tau² = 0.65; Chi² = 6.18, df = 4 (P = 0.19); I² = 35%								
Test for overall effect: Z = 2.51 (P = 0.01)								

Test for subgroup differences: Chi² = 10.59, df = 3 (P = 0.01); I² = 71.7%

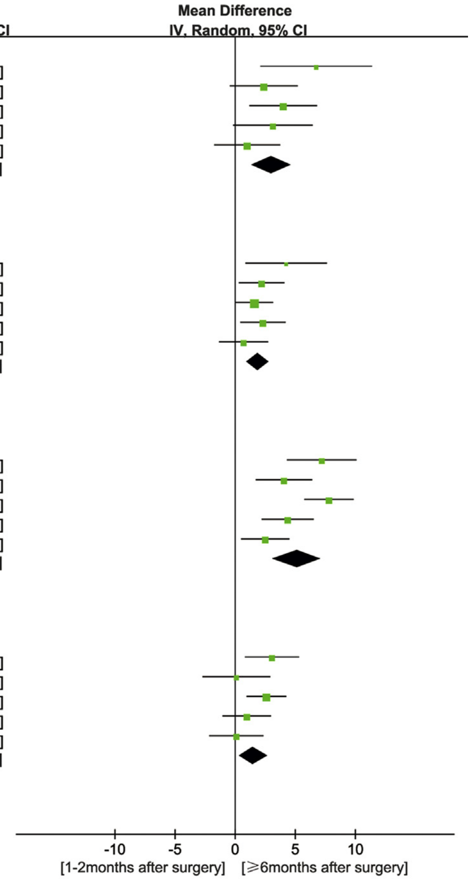


Fig 5. Forest plot for the comparison of individual dimensions in OQLQ-22 1-2 months after surgery vs ≥6 months after surgery.

of OQLQ-22 scores, it appeared that the OHRQoL of patients would improve after COST, which was further supported by the stable data in sensitivity analysis and the consistent result in meta-analysis of OHIP-14 scores. Moreover, we identified how COST benefits OHRQoL through the analysis of individual domains in OQLQ-22. Based on our results, the treatment seems to be effective to optimize oral functions and facial esthetics by correcting dentofacial deformities. Subsequently, social well-being is improved, and then improvement of OHRQoL occurs.[48]

Another important qualitative finding of this review is the outline of OHRQoL changes at different stages of COST. Based on our results, the OHRQoL slightly decreases in the presurgical orthodontic treatment, especially in the domains of facial esthetics and oral function. Patients undergoing dental decompensation in presurgical treatment are thought to have lower OHRQoL due to the temporarily deteriorated occlusion and facial profile during this period, which is proved by our results. We also identified the significant improvement of OHRQoL in the postsurgical orthodontic treatment. Current conclusions on the changes of OHRQoL during orthognathic surgery seem unreliable due to the unstable results observed in sensitivity analysis (Table II) and the different pooled estimate between the condition-specific (OQLQ-22; Fig 2) and general OHRQoL (OHIP-14; Supplementary Fig 1).

Besides the high expenses and long treatment duration, the esthetic and functional drawbacks during presurgical treatment are the main concerns for patients seeking COST.[9] Recently, the surgery-first approach has been proposed to overcome the weakness associated with dental decompensation by simplifying the treatment protocol as a 2-step approach consisting of the surgery and the postsurgical orthodontic treatment.[10] However, its actual effects remains uncertain,[49] and the strict indications[11] and questionable posttreatment stability[12] limit its application to clinics. Moreover, although the reduction of OHRQoL in the presurgical period of COST was identified by this review, whether the surgery-first approach could perform better than

Study or Subgroup	before treatment Mean	SD	Total	≥6months after surgery Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
7.4.1 social aspects								
Alanko 2017	7.23	8.29	22	2.86	5.29	22	35.0%	4.37 [0.26, 8.48]
Choi 2010	13.88	8.12	32	8.65	6.48	32	45.7%	5.23 [1.63, 8.83]
Tachiki 2018	17.8	10.03	20	12.8	7.69	20	19.3%	5.00 [-0.54, 10.54]
Subtotal (95% CI)			**74**			**74**	**100.0%**	**4.88 [2.45, 7.32]**
Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 2 (P = 0.95); I² = 0%								
Test for overall effect: Z = 3.94 (P < 0.0001)								
7.4.2 facial aesthetics								
Alanko 2017	8.45	6.31	22	4.23	4.39	22	16.4%	4.22 [1.01, 7.43]
Choi 2010	13.63	4.76	32	7.74	3.75	32	38.4%	5.89 [3.79, 7.99]
Tachiki 2018	15.1	2.65	20	9.5	3.54	20	45.1%	5.60 [3.66, 7.54]
Subtotal (95% CI)			**74**			**74**	**100.0%**	**5.48 [4.18, 6.79]**
Heterogeneity: Tau² = 0.00; Chi² = 0.75, df = 2 (P = 0.69); I² = 0%								
Test for overall effect: Z = 8.26 (P < 0.00001)								
7.4.3 oral function								
Alanko 2017	10.76	4.73	22	5	3.55	22	24.7%	5.76 [3.29, 8.23]
Choi 2010	9.31	4.93	32	5	3.76	32	32.7%	4.31 [2.16, 6.46]
Tachiki 2018	7.8	2.94	20	3.9	3.13	20	42.6%	3.90 [2.02, 5.78]
Subtotal (95% CI)			**74**			**74**	**100.0%**	**4.49 [3.27, 5.72]**
Heterogeneity: Tau² = 0.00; Chi² = 1.42, df = 2 (P = 0.49); I² = 0%								
Test for overall effect: Z = 7.17 (P < 0.00001)								
7.4.4 awareness								
Alanko 2017	4.77	4.1	22	2.41	3.19	22	33.3%	2.36 [0.19, 4.53]
Choi 2010	7.91	4.26	32	6.9	4.23	32	34.9%	1.01 [-1.07, 3.09]
Tachiki 2018	9.2	4.02	20	9.8	3.21	20	31.8%	-0.60 [-2.85, 1.65]
Subtotal (95% CI)			**74**			**74**	**100.0%**	**0.95 [-0.69, 2.59]**
Heterogeneity: Tau² = 0.88; Chi² = 3.44, df = 2 (P = 0.18); I² = 42%								
Test for overall effect: Z = 1.13 (P = 0.26)								

Test for subgroup differences: Chi² = 19.32, df = 3 (P = 0.0002), I² = 84.5%

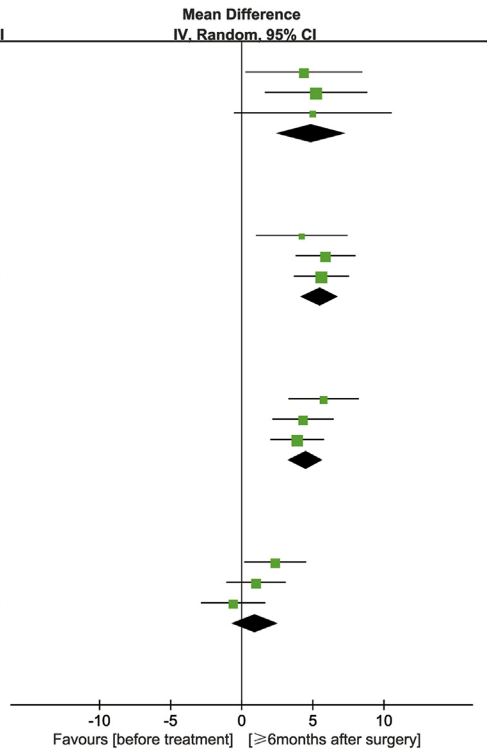


Fig 6. Forest plot for the comparison of individual dimensions in OQLQ-22 before treatment vs ≥6 months after surgery.

COST is unclear yet. More studies to compare the impact of COST and surgery-first approach are required to clarify this question.

A problem frequently encountered when conducting the meta-analysis of OHRQoL data is the involvement of different measures of assessment. The common solution is to use the standardized MD as the effect size for statistics.[50] However, this method was not applicable to this review because 5 studies included in the quantitative analysis used OQLQ-22 and OHIP-14 simultaneously. In the present study, data of the 2 measures were analyzed separately. The total scores of the OQLQ-22 questionnaire, which is designed to measure the condition-specific OHRQoL for orthognathic patients, were defined as the main outcomes because the questionnaire content is closely associated with the concerns of patients suffering from severe dentofacial deformities and undergoing orthognathic surgery.[51] We used the pooled data of OHIP-14, which is an indicator of general OHRQoL as supplementary evidence of the main outcomes. Interestingly, it was observed that the combined estimates of OHIP-14 data were consistent with all main outcomes that sensitivity analyses failed to cause significant changes, but contradicted the main outcome that was unstable in sensitivity analyses. This finding indicates the favorable concordance of condition-specific (OQLQ-22) and general OHRQoL (OHIP-14) on reliable results, as well as demonstrates that our method to handle the data measured by different instruments was acceptable.

Limitations

Although the present study was strictly conducted, some limitations must be considered when interpreting the results. The major concern is the lack of high-quality clinical trials. Although RCTs and CCTs were expected for this review, 23 of the 24 eligible studies were cohort studies, and the only RCT was included because it involved participants who received the evaluation of OHRQoL before and after treatment rather than comparison of randomly assigned groups according to receiving COST or not. This was unsurprising, because assigning individuals who require COST to the group subjected to orthodontic treatment alone or even no treatment is unethical.

The substantial heterogeneity among the recruited studies is another confounding factor that might have directly influenced the results. Although we tried to explore the heterogeneity source via sensitivity analysis, unclear heterogeneity remained, which could be caused by several factors as follows. First, different types of dentofacial deformities were involved in the meta-analysis.

Recent studies revealed that differences may exist in the perceptions to quality of life in patients with different deformities either before or after orthognathic treatment.[31,35,42] However, subgroup analysis was not applicable based on the current data to quantitatively investigate the OHRQoL changes in participants with specific types of deformity. Second, the timings of OHRQoL assessments, especially those after surgery, varied significantly among the included studies, which could introduce heterogeneity. Third, because the evaluation of OHRQoL by means of self-reported questionnaire is a rather subjective approach, the result could be influenced by many factors, including gender and age,[42,52] so the variance in demographic characteristics of the studies could also be a source of heterogeneity.

Recommendations for future research

Although no high-quality evidence was obtained in the present review owing to the limits of original studies, this comprehensive review of currently available literature provides some recommendations for future research on this issue. First, comparison groups based on receiving COST or not are suggested to be established when conducting clinical trials. Second, besides the statistical analysis on the whole sample, the data should also be analyzed separately according to the types of dentofacial deformities and surgical approaches. Third, the timing for OHRQoL assessment should be more carefully determined, especially at the placement and removal of orthodontic appliances, and longer follow-ups are needed to clarify the effect of a complete COST and the long-term effect.

CONCLUSION

Based on this systematic review and meta-analysis, the conventional orthodontic-surgical treatment could improve the condition-specific OHRQoL of patients, especially in the aspects of social well-being, oral function, and facial esthetics. Compared with before treatment, the condition-specific OHRQoL seems to decrease during the presurgical orthodontic treatment and then increase significantly in the postsurgical orthodontic treatment. A similar pattern was observed in the changes of general OHRQoL. Future high-quality studies, especially RCTs, are needed to obtain more reliable conclusions and to further investigate the impacts on specific types of deformities with longer follow-ups.

ACKNOWLEDGMENTS

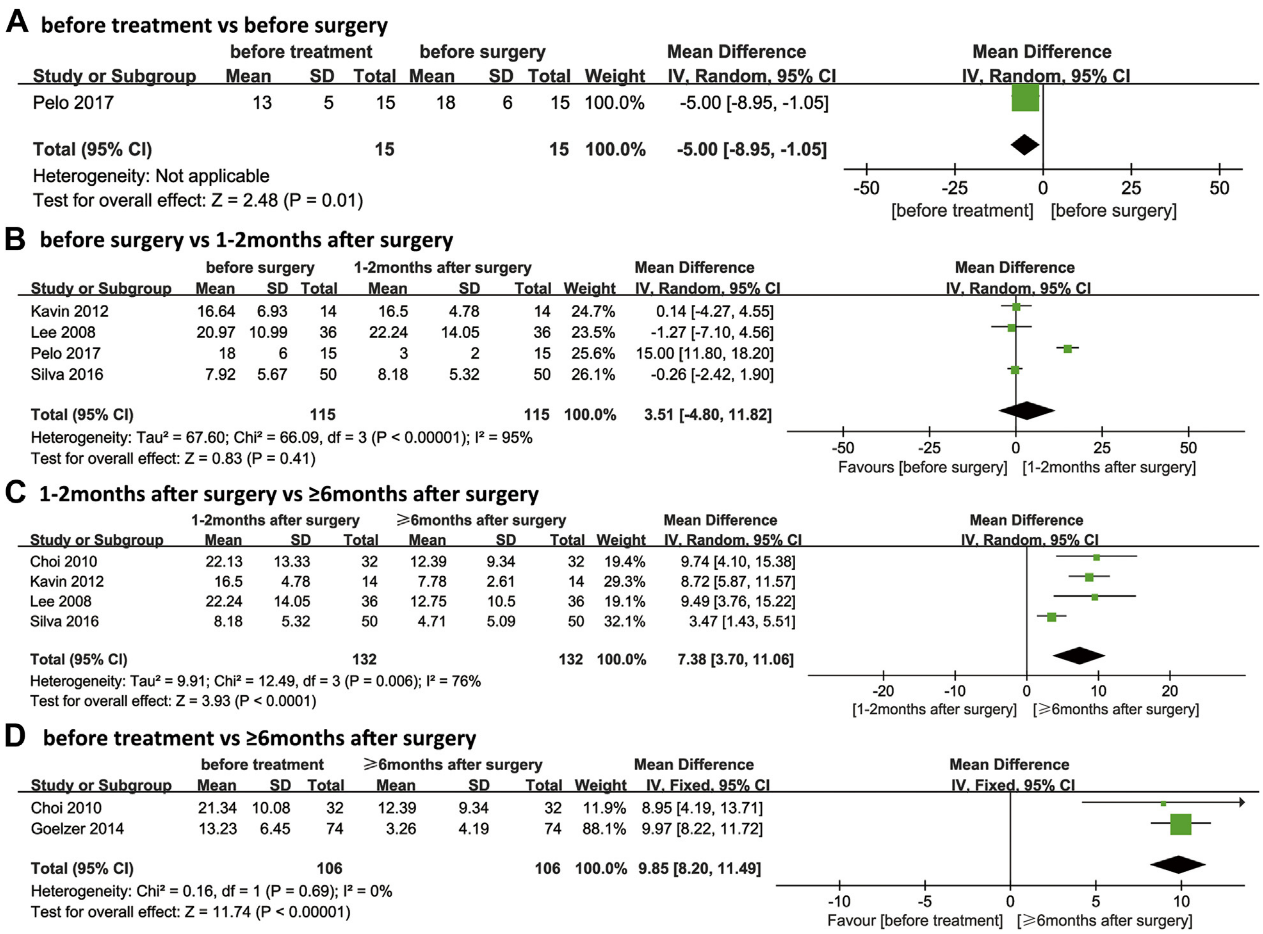
This study was supported by the National Natural Science Foundation of China (NSFC) [grant number 81801018] and by Orthodontic National Key Clinical specialty Program of China, West China Hospital of Stomatology, Sichuan University.

REFERENCES

1. Dimberg L, Arnrup K, Bondemark L. The impact of malocclusion on the quality of life among children and adolescents: a systematic review of quantitative studies. Eur J Orthod 2015;37:238-47.
2. Al-Kharboush GH, Asimakopoulou K, AlJabaa AH, Newton JT. The role of social comparison in social judgments of dental appearance: an experimental study. J Dent 2017;61:33-8.
3. Javidi H, Vettore M, Benson PE. Does orthodontic treatment before the age of 18 years improve oral health-related quality of life? A systematic review and meta-analysis. Am J Orthod Dentofacial Orthop 2017;151:644-55.
4. Posnick J. Orthognathic surgery: principles and practice. Amsterdam: Elsevier; 2013.
5. Harrington C, Gallagher JR, Borzabadi-Farahani A. A retrospective analysis of dentofacial deformities and orthognathic surgeries using the index of orthognathic functional treatment need (IOFTN). Int J Pediatr Otorhinolaryngol 2015;79:1063-6.
6. Bailey L, Cevidanes LH, Proffit WR. Stability and predictability of orthognathic surgery. Am J Orthod Dentofacial Orthop 2004; 126:273-7.
7. Sharma VK, Yadav K, Tandon P. An overview of surgery-first approach: Recent advances in orthognathic surgery. J Orthod Sci 2015;4:9-12.
8. Proffit WR, Miguel JA. The duration and sequencing of surgical-orthodontic treatment. Int J Adult Orthodon Orthognath Surg 1995;10:35-42.
9. Ryan FS, Barnard M, Cunningham SJ. Impact of dentofacial deformity and motivation for treatment: a qualitative study. Am J Orthod Dentofacial Orthop 2012;141:734-42.
10. Hernandez-Alfaro F, Guijarro-Martinez R, Peiro-Guijarro MA. Surgery first in orthognathic surgery: what have we learned? A comprehensive workflow based on 45 consecutive cases. J Oral Maxillofac Surg 2014;72:376-90.
11. Liou EJ, Chen PH, Wang YC, Yu CC, Huang CS, Chen YR. Surgery-first accelerated orthognathic surgery: orthodontic guidelines and setup for model surgery. J Oral Maxillofac Surg 2011;69:771-80.
12. Wei H, Liu Z, Zang J, Wang X. Surgery-first/early-orthognathic approach may yield poorer postoperative stability than conventional orthodontics-first approach: a systematic review and meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol 2018;126:107-16.
13. Pelo S, Saponaro G, Patini R, Staderini E, Giordano A, Gasparini G, et al. Risks in surgery-first orthognathic approach: complications of segmental osteotomies of the jaws. A systematic review. Eur Rev Med Pharmacol Sci 2017;21:4-12.
14. Sischo L, Broder HL. Oral health-related quality of life: what, why, how, and future implications. J Dent Res 2011;90:1264-70.
15. Jesani A, DiBiase AT, Cobourne MT, Newton T. Perceived changes by peer group of social impact associated with combined orthodontic-surgical correction of class III malocclusion. J Dent 2014;42:1135-42.
16. Palomares NB, Celeste RK, Miguel JA. Impact of orthosurgical treatment phases on oral health-related quality of life. Am J Orthod Dentofacial Orthop 2016;149:171-81.
17. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009;339:b2535.

18. Higgins JP, Altman DG, Gotzsche PC, Juni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.
19. Stang A. Critical evaluation of the Newcastle-Ottawa Scale for the assessment of the quality of nonrandomized studies in meta-analyses. Eur J Epidemiol 2010;25:603-5.
20. Song F, Eastwood AJ, Gilbody S, Duley L, Sutton AJ. Publication and related biases. Health Technol Assess 2000;4:1-115.
21. Huang S, Chen W, Ni Z, Zhou Y. The changes of oral health-related quality of life and satisfaction after surgery-first orthognathic approach: a longitudinal prospective study. Head Face Med 2016;12:2.
22. Corso PF, Oliveira FA, Costa DJ, Kluppel LE, Rebellato NL, Scariot R. Evaluation of the impact of orthognathic surgery on quality of life. Braz Oral Res 2016;30.
23. Feu D, de Oliveira BH, Palomares NB, Celeste RK, Miguel JAM. Oral health-related quality of life changes in patients with severe Class III malocclusion treated with the 2-jaw surgery-first approach. Am J Orthod Dentofacial Orthop 2017;151:1048-57.
24. Wang J, Chen W, Ni Z, Zheng M, Liang X, Zheng Y, et al. Timing of orthognathic surgery on the changes of oral health-related quality of life in Chinese orthognathic surgery patients. Am J Orthod Dentofacial Orthop 2017;151:565-71.
25. Azuma S, Kohzuki M, Saeki S, Tajima M, Igarashi K, Sugawara J. Beneficial effects of orthodontic treatment on quality of life in patients with malocclusion. Tohoku J Exp Med 2008;214:39-50.
26. Lee S, McGrath C, Samman N. Impact of orthognathic surgery on quality of life. J Oral Maxillofac Surg 2008;66:1194-9.
27. Choi WS, Lee S, McGrath C, Samman N. Change in quality of life after combined orthodontic-surgical treatment of dentofacial deformities. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:46-51.
28. Khadka A, Liu Y, Li J, Zhu S, Luo E, Feng G, et al. Changes in quality of life after orthognathic surgery: a comparison based on the involvement of the occlusion. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:719-25.
29. Murphy C, Kearns G, Sleeman D, Cronin M, Allen PF. The clinical relevance of orthognathic surgery on quality of life. Int J Oral Maxillofac Surg 2011;40:926-30.
30. Kavin T, Jagadesan AG, Venkataraman SS. Changes in quality of life and impact on patients' perception of esthetics after orthognathic surgery. J Pharm Bioallied Sci 2012;4:S290-3.
31. Goelzer JG, Becker OE, Haas Junior OL, Scolari N, Santos Melo MF, Heitz C, et al. Assessing change in quality of life using the Oral Health Impact Profile (OHIP) in patients with different dentofacial deformities undergoing orthognathic surgery: a before and after comparison. Int J Oral Maxillofac Surg 2014;43:1352-9.
32. Rustemeyer J, Gregersen J. Quality of Life in orthognathic surgery patients: post-surgical improvements in aesthetics and self-confidence. J Craniomaxillofac Surg 2012;40:400-4.
33. Baherimoghaddam T, Tabrizi R, Naseri N, Pouzesh A, Oshagh M, Torkan S. Assessment of the changes in quality of life of patients with Class II and III deformities during and after orthodontic-surgical treatment. Int J Oral Maxillofac Surg 2016;45:476-85.
34. Abdullah WA. Changes in quality of life after orthognathic surgery in Saudi patients. Saudi Dent J 2015;27:161-4.
35. Kurabe K, Kojima T, Kato Y, Saito I, Kobayashi T. Impact of orthognathic surgery on oral health-related quality of life in patients with jaw deformities. Int J Oral Maxillofac Surg 2016;45:1513-9.
36. Silva I, Cardemil C, Kashani H, Bazargani F, Tarnow P, Rasmusson L, et al. Quality of life in patients undergoing orthognathic surgery—a two-centered Swedish study. J Craniomaxillofac Surg 2016;44:973-8.
37. Alanko O, Tuomisto MT, Peltomaki T, Tolvanen M, Soukka T, Svedstrom-Oristo AL. A longitudinal study of changes in psychosocial well-being during orthognathic treatment. Int J Oral Maxillofac Surg 2017;46:1380-6.
38. Pelo S, Gasparini G, Garagiola U, Cordaro M, Di Nardo F, Staderini E, et al. Surgery-first orthognathic approach vs traditional orthognathic approach: Oral health-related quality of life assessed with 2 questionnaires. Am J Orthod Dentofacial Orthop 2017;152:250-4.
39. Eslamipour F, Najimi A, Tadayonfard A, Azamian Z. Impact of orthognathic surgery on quality of life in patients with dentofacial deformities. Int J Dent 2017;2017:4103905.
40. Emadian Razvadi ES, Soheilifar S, Esmaeelinejad M, Naghdi N. Evaluation of the changes in the quality of life in patients undergoing orthognathic surgery: a multicenter study. J Craniofac Surg 2017;28:e739-43.
41. Nichols GAL, Antoun JS, Fowler PV, Al-Ani AH, Farella M. Long-term changes in oral health-related quality of life of standard, cleft, and surgery patients after orthodontic treatment: a longitudinal study. Am J Orthod Dentofacial Orthop 2018;153:224-31.
42. Sun H, Shang HT, He LS, Ding MC, Su ZP, Shi YL. Assessing the quality of life in patients with dentofacial deformities before and after orthognathic surgery. J Oral Maxillofac Surg 2018;76:2192-201.
43. Tachiki C, Nishii Y, Takaki T, Sueishi K. Condition-specific quality of life assessment at each stage of Class III surgical orthodontic treatment—a prospective study. Bull Tokyo Dent Coll 2018;59:1-14.
44. Bengtsson M, Wall G, Larsson P, Becktor JP, Rasmusson L. Treatment outcomes and patient-reported quality of life after orthognathic surgery with computer-assisted 2- or 3-dimensional planning: a randomized double-blind active-controlled clinical trial. Am J Orthod Dentofacial Orthop 2018;153:786-96.
45. Song YL, Yap AUJ. Orthognathic treatment of dentofacial disharmonies: its impact on temporomandibular disorders, quality of life, and psychosocial wellness. Cranio 2017;35:52-7.
46. Park HM, Lee YK, Choi JY, Baek SH. Maxillary incisor inclination of skeletal Class III patients treated with extraction of the upper first premolars and two-jaw surgery: conventional orthognathic surgery vs surgery-first approach. Angle Orthod 2014;84:720-9.
47. Kim CS, Lee SC, Kyung HM, Park HS, Kwon TG. Stability of mandibular setback surgery with and without presurgical orthodontics. J Oral Maxillofac Surg 2014;72:779-87.
48. Twigge E, Roberts RM, Jamieson L, Dreyer CW, Sampson WJ. The psycho-social impact of malocclusions and treatment expectations of adolescent orthodontic patients. Eur J Orthod 2016;38:593-601.
49. Peiro-Guijarro MA, Guijarro-Martinez R, Hernandez-Alfaro F. Surgery first in orthognathic surgery: a systematic review of the literature. Am J Orthod Dentofacial Orthop 2016;149:448-62.
50. Douglas-de-Oliveira DW, Vitor GP, Silveira JO, Martins CC, Costa FO, Cota LOM. Effect of dentin hypersensitivity treatment on oral health related quality of life—a systematic review and meta-analysis. J Dent 2018;71:1-8.
51. Cunningham SJ, Garratt AM, Hunt NP. Development of a condition-specific quality of life measure for patients with dentofacial deformity: I. Reliability of the instrument. Community Dent Oral Epidemiol 2000;28:195-201.
52. Bortoluzzi MC, de Camargo Smolarek P, Claudino M, Campagnoli EB, Manfro R. Impact of dentofacial deformity on quality of life: age and gender differences evaluated through OQLQ, OHIP and SF36. J Oral Maxillofac Res 2015;6:e3.

APPENDIX



Supplementary Fig 1. Forest plot for the total scores of OHIP-14: **A,** before treatment vs before surgery; **B,** before surgery vs 1-2 months after surgery; **C,** 1-2 months after surgery vs ≥6 months after surgery; **D,** before treatment vs ≥6 months after surgery.

Supplementary Table I. Search strategies for each database

Database	*Search strategy*
PubMed	(Orthodontics [Mesh] OR orthodont*) AND (Orthognathic Surgical Procedures [Mesh] OR orthognathic OR surgery OR surgical OR osteotomy OR Le Fort OR sagittal split ramus) AND (Quality of Life [Mesh] OR quality of life OR Oral Health-related Quality of Life OR OHRQoL)
Embase	(orthodont*) AND (orthognathic OR surgery OR surgical OR osteotomy OR Le Fort OR sagittal split ramus) AND (quality of life OR Oral Health-related Quality of Life OR OHRQoL)
CENTRAL	(orthodont*) AND (orthognathic OR surgery OR surgical OR osteotomy OR Le Fort OR sagittal split ramus) AND (quality of life OR Oral Health-related Quality of Life OR OHRQoL)
CNKI	(orthodont*) AND (orthognathic OR surgery OR surgical OR osteotomy OR Le Fort OR sagittal split ramus) AND (quality of life OR Oral Health-related Quality of Life OR OHRQoL)
ProQuest Dissertation and Theses	(orthodont*) AND (orthognathic OR surgery) AND (Oral Health-related Quality of Life OR OHRQoL)
SIGLE	(orthodontic) AND (orthognathic) AND (Oral Health-related Quality of Life)

Supplementary Table II. Summary of excluded studies

Title	*Reason*
Survey of oral health–related quality of life among skeletal malocclusion patients following orthodontic treatment and orthognathic surgery	No appropriate intervention
Assessment of quality of life in patients undergoing orthognathic surgery	No appropriate intervention
Pathways between temporomandibular disorders, occlusal characteristics, facial pain, and oral health–related quality of life among patients with severe malocclusion	No appropriate intervention
Oral health–related quality of life changes in standard, cleft, and surgery patients after orthodontic treatment	No appropriate intervention
Quality of life in patients with severe malocclusion before treatment	No appropriate intervention
A comparison of health-related quality of life between Jordanian and British orthognathic patients	No appropriate intervention
Psychosocial well-being of prospective orthognathic-surgical patients	No appropriate intervention
Quality of life and self-esteem of female orthognathic surgery patients	No appropriate intervention
Occlusal characteristics and quality of life before and after treatment of severe malocclusion	No appropriate intervention
Patients' perception of improvement after orthognathic surgery: pilot study	Retrospective study
Patient's satisfaction in skeletal Class III cases treated with two-jaw surgery using orthognathic quality of life questionnaire: conventional three-stage method versus surgery-first approach	Retrospective study
Patients' perceptions of improvements after bilateral sagittal split osteotomy advancement surgery: 10 to 14 years of follow-up	Retrospective study
Do changes in oral health–related quality-of-life, facial pain and temporomandibular disorders correlate after treatment of severe malocclusion?	No appropriate intervention
Self-esteem and depression in patients presenting Angle Class III malocclusion submitted for orthognathic surgery	No validated instrument
Changes in cephalometric variables after orthognathic surgery and their relationship to patients' quality of life and satisfaction	No appropriate intervention
Correlation of general and oral health–related quality of life in malocclusion patients treated with a combined orthodontic and maxillofacial surgical approach	No effective data on OHRQoL
Survey of oral health–related quality of life among skeletal malocclusion patients following orthodontic treatment and orthognathic surgery	No effective data on OHRQoL
Patient satisfaction and oral health–related quality of life 10-15 years after orthodontic-surgical treatment of mandibular prognathism	Retrospective study
Survey of patient experiences of orthognathic surgery: health-related quality of life and satisfaction	Cross-sectional study
Oral health–related quality of life in orthognathic surgery patients	Cross-sectional study
Health-related quality of life and psychosocial function 5 years after orthognathic surgery	Patients younger than 16 y involved
An assessment of the quality of life of patients with Class III deformities treated with orthognathic surgery	Cross-sectional study
Impact of orthosurgical treatment phases on oral health–related quality of life	Cross-sectional study
Changes in quality of life and their relation to cephalometric changes in orthognathic surgery patients	No effective data on OHRQoL
Surgery-first approach in orthognathic surgery: psychological and biological aspects—a prospective cohort study	Only surgery-first patients
Dental esthetics and quality of life in adults with severe malocclusion before and after treatment	Retrospective study
Assessment of the quality of life in Moroccan patients undergoing orthognathic surgery	Retrospective study
Subjective and objective treatment outcomes of maxillomandibular advancement for the treatment of obstructive sleep apnea syndrome	No effective data on OHRQoL

Supplementary Table III. Quality assessment of the included cohort studies with Newcastle-Ottawa Scale

	Selection					*Outcome*			
Study	*Representativeness*	*Selection of the nonexposed*	*Ascertainment of exposure*	*Change in outcome*	*Comparability*	*Assessment of outcome*	*Duration of outcome*	*Adequacy of outcome*	*Total score*
Azuma	b*	a*	a*	a*	a*	C	a*	d	6
Lee	b*	a*	a*	a*	a*	C	a*	a*	7
Choi	b*	a*	a*	a*	a*	C	a*	b*	7
Khadka	b*	a*	a*	a*	a*	C	a*	b*	7
Murphy	a*	a*	a*	a*	a*	C	a*	b*	7
Kavin	b*	a*	a*	a*	a*	C	a*	d	6
Rustmeyer	b*	a*	a*	a*	a*	C	b	a*	7
Goelzer	b*	a*	a*	a*	a*	C	a*	a*	7
Baherimoghaddam	b*	a*	a*	a*	a*	C	a*	b*	7
Kurabe	b*	a*	a*	a*	a*	C	a*	d	6
Silva	b*	a*	a*	a*	a*	C	a*	b*	7
Huang	b*	a*	a*	a*	a*	C	b	d	5
Corso	b*	a*	a*	a*	a*	C	b	d	5
Alanko	b*	a*	a*	a*	a*	C	a*	c	6
Feu	b*	a*	a*	a*	a*	C	b	d	5
Wang	b*	a*	a*	a*	a*	C	b	d	5
Pelo	b*	a*	a*	a*	a*	C	a*	d	6
Eslamipour	b*	a*	a*	a*	a*	C	a*	c	6
Razvadi	b*	a*	a*	a*	a*	C	a*	b*	7
Abdullah	b*	a*	a*	a*	a*	C	a*	d	6
Nichols	b*	a*	a*	a*	a*	C	a*	d	6
Sun	b*	a*	a*	a*	a*	C	a*	d	6
Tachiki	b*	a*	a*	a*	a*	c	a*	b*	7

Supplementary Table IV. Quality assessment of the included RCT with Cochrane Handbook for Systematic Reviews of Interventions

Study	*Random sequence generation*	*Allocation concealment*	*Blinding of participants and personnel*	*Blinding of outcome assessment*	*Incomplete outcome data*	*Selective reporting*	*Other bias*
Bengtsson	Low risk	Low risk	Unclear risk	Unclear risk	Low risk	Low risk	Unclear risk