International Journal of Surgery 38 (2017) 31–40

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Review

Impact on the upper airway space of different types of orthognathic surgery for the correction of skeletal class III malocclusion: A systematic review and meta-analysis

Jinlong He [a, b, c, 1], Yunji Wang [a, b, c, 1], Hongtao Hu [a, b, c], Qian Liao [a, b, c], Weiyi Zhang [a, b, c], Xuerong Xiang [a, b, c, *], Xiaoping Fan [a, b, c, *]

[a] College of Stomatology, Chongqing Medical University, Chongqing, China
[b] Chongqing Key Laboratory for Oral Diseases and Biomedical Sciences, Chongqing, China
[c] Chongqing Municipal Key Laboratory of Oral Biomedical Engineering of Higher Education, Chongqing, China

HIGHLIGHTS

- Two-jaw surgery caused a smaller reduction in the PNS-CSA, EP-CSA, nasopharynx volume and upper airway total volume compared with one-jaw surgery.
- Bimaxillary surgery promotes less decrease on the upper airway than mandibular setback surgery alone for the correction of the skeletal class III malocclusion.

ARTICLE INFO

Article history:
Received 24 August 2016
Received in revised form
9 November 2016
Accepted 18 December 2016
Available online 24 December 2016

Keywords:
Mandibular setback
Bimaxillary surgery
Skeletal class III malocclusion
Upper airway
Meta-analysis

ABSTRACT

Objective: This study is aimed at assembling, through a systematic review and meta-analysis, scientific evidence related to the effects of mandibular setback (MdS) surgery and bimaxillary surgery for the correction of Class III malocclusion on the cross-sectional area (CSA) and volume of the upper airway as assessed using CT.

Methods: An electronic search was conducted on Cochrane Library, EMBASE, PubMed, Scopus and Web of Science up to June 20, 2016. The inclusion criteria were prospective or retrospective studies, with the aim of comparing the impact on the upper airway space of orthognathic surgery for the treatment of the skeletal class III malocclusion. The methodological index for non-randomized studies (MINORS) was chosen as the evaluation instrument and Revman5.3 was used for the meta-analysis.

Results: A total of 1213 studies were retrieved, of which only 18 met the eligibility criteria. The results of meta-analysis showed that the mean decrease in the upper airway volume after MdS surgery was 3.24 cm^3 [95%CI (−5.25,-1.23), p = 0.85]; the mean decrease in minimum CSA after a combined surgery of maxillary advancement with mandibular setback (MdS + MxA) was 27.66 mm^2 [95%CI (−52.81,−2.51), p = 0.51], but there was no significant decrease in upper airway volume (mean 0.86 cm^3); comparison between MdS + MxA and isolated MdS showed significant differences in the CSA of the posterior nasal spine plane (PNS) and epiglottis plane (EP); statistically significant differences in nasopharynx volume (P < 0.0001) and upper airway total volume (P = 0.002) were observed, but no statistically meaningful variations existed in oropharynx volume (P = 0.08) and hypopharynx volume (P = 0.64).

Conclusion: The results of this study suggest that bimaxillary surgery promotes less decrease on the upper airway than mandibular setback surgery alone for the correction of the skeletal class III malocclusion.

1. Introduction

Skeletal class III malocclusion is common in clinical cases [1–3], In the 1920s surgery began to be used for the treatment of skeletal

* Corresponding authors. 426#Songshibei Road, Yubei District, Chongqing 401147, China.
E-mail addresses: cqzxfxp@sina.com (X. Xiang), fanxp666@163.com (X. Fan).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.ijsu.2016.12.033
1743-9191/

class III malocclusion, and by the 1960s maxillary LeFort I osteotomy had become the treatment of choice, because it was more effective than mandibular setback in terms of improving patients' alignment of jaws and their overall facial symmetry [4]. Malocclusion problems may reoccur after surgery due to the traction of soft tissues and muscle forces produced during function, therefore, in the 1970s orthodontic treatment was combined with orthognathic surgery to correct malocclusion, stable and desirable effects were achieved [5].

Currently, combined orthodontic and orthognathic surgical therapy has proved the most effective for the treatment of skeletal class III malocclusion when it comes to enhancing function and aesthetics. Skeletal changes caused by the surgery, however, can alter the positions and traction of the surrounding soft tissues, tongue, soft palate, hyoid bone and muscles, and can change airway volume and the size of oral and nasal cavities [6–9]. According to most previous studies [10–12], mandibular setback surgery may affect the relationship between the soft and skeletal tissues, subsequent increase in upper airway resistance and decrease in upper airway space. Besides, bimaxillary surgical caused a smaller decrease in airway space compared to mandibular setback surgery. On the other hand, some studies [13–15] concluded that bimaxillary orthognathic surgery for the correction of Class III malocclusion resulted in increased total airway volume. Therefore, changes in the upper airway space resulting from different types of orthognathic surgery still remain controversial.

Moreover, no meta-analysis that compares changes in the airway dimensions resulting from different types of orthognathic surgery for the correction of skeletal class III malocclusion exclusively using 3D examination has been documented in the literature. Three previous systematic reviews [2,16,17] have investigated based on data from two-dimensional images, as some articles using three dimensional images were not comparable, didn't perform meta analysis. Therefore, the present meta-analysis focused only on studies that used CT airway evaluation, particularly cone beam CT (CBCT). This study is aimed at assembling, through a meta-analysis, scientific evidence related to the effects of MdS and bimaxillary surgery for the correction of Class III malocclusion on the CSA and volume of the upper airway as assessed using 3D examination so as to inform treatment planning for patients suffering skeletal class III malocclusion.

2. Materials and methods

2.1. Inclusion criteria and exclusion criteria

The inclusion criteria were developed according to the PICOS criteria (Table 1). Exclusion criteria were as follows: (1) Research type: animal studies, case reports, studies that did not provide the data needed to conduct meta-analysis; (2) Research object: patients with cleft palate, pharyngeal airway dysfunction, wounds, burns or temporomandibular joint disorders, the syndrome of obstructive sleep apnea; (3) Intervention: orthognathic surgery combined with other surgeries, such as genioplasty, maxillary impaction.

2.2. Literature search strategy

This systematic review and meta-analysis were conducted following the statement of PRISMA [18] (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). An electronic search in Cochrane Library, EMBASE, PubMed, Scopus and Web of Science, until June 20, 2016. An additional manual search of references in the included studies was also conducted. We used the search terms combination [“Malocclusion, Angle Class III” OR “mandible” OR “maxilla” OR “Orthognathic Surgery” AND (“Pharynx” OR “Nasopharynx” OR “Hypopharynx” OR “Oropharynx”)].

Table 1
PICOS criteria for the systematic review.

Population (P)	Patients with a prognathic mandible and class III malocclusion who had undergone mandible setback or bimaxillary surgery; age 15–50 years
Intervention (I)	Mandibular setback surgery (IVRO or BSSO), or bimaxillary surgery
Comparison (C)	Between the different orthognathic surgeries or comparison between pre-surgery and post-surgery parameters
Outcome (O)	Changes of the upper airway (three CSA parameters: PNS-CSA, SP-CSA and EP-CSA; four volume parameters:nasopharynx volume, oropharynx volume, hypopharynx volume, and upper airway total volume)
Study design (S)	Prospective or retrospective studies with the aim of comparing upper airway space changes of different surgical procedures or pre-surgery and post-surgery parameters for the prognathic mandible
Question	What are the effects of different orthognathic surgeries for the correction of the prognathic mandible on the dimensions of the upper airways assessed using CT?

IVRO, intraoral vertical ramus osteotomy; BSSO, bilateral sagittal split osteotomy.

2.3. Data extraction

An initial screening through titles and abstracts was conducted independently by two reviewers (HJL, WYJ), who then cross-checked and reviewed the text in full to decide whether they were eligible. Disagreements were resolved through discussion, when necessary, by seeking the opinion of a third reviewer. The following data were extracted from the studies included in the final analysis: title, author, year of publication, study design, age and gender of research objects, sample size, surgical procedure, evaluation parameters and other statistical data.

2.4. Quality assessment of the included studies

Prospective or retrospective studies reporting on the upper airway space change upon orthognathic surgery were selected. Quality of included studies were assessed using MINORS [19], which is tailored to quality evaluation of non-randomized controlled studies and is comprised of twelve items, with each item scored from 0 to 2. So the total score is 24. On the basis of other researchers, 0–12 showed high risk of bias, 13 to 18 for moderate risk of bias, and 19–24 for low risk of bias. Quality of included studies were assessed independently by two reviewers in accordance to MINORS and a conclusion was reached after disagreements were resolved through discussion.

2.5. Statistical analysis

Extracted data were statistically analyzed using Review Manager 5.3. All available data extracted from the included studies were continuous variables, mean and standardized mean difference (SMD) or weighted mean difference (WMD) with a 95% confidence interval was used to estimate treatment effect. Cochrane's test (I^2 statistic) was used to evaluate heterogeneity. Low heterogeneity ($P > 0.10$, $I^2<50\%$) means fixed-effects model should be employed to conduct the meta-analysis. If heterogeneity was substantial ($P \leq 0.10$, $I^2 \geq 50\%$), then random-effects model was adopted. The statistical significance for the testing of hypotheses was set at $p < 0.05$. Funnel plots were used to detect publication bias and a symmetrical plot indicated low risk publication bias.