Cephalometric data differences in Angle III patients selected for camouflage treatment and orthognathic surgery: a systematic review

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Abstract

Defining the best treatment for Angle Class III patients is a challenge. The purpose of this systematic review is to examine which is the most reliable cephalometric parameter for choosing proper treatment modality in class III cases. Searches were made in the PubMed and Cochrane Library databases. The criteria for eligibility were: class III patients who had undergone orthognatic or camouflage orthodontic treatment. Patients with syndromes, craniofacial deformities or skeletal asymetries were excluded. The folowing variables were recorded for each article: author, year of publication, population size, treatment carried out and cephalometric data. Initially, 214 articles were identified. After removing the duplicates and applying the selection criteria, 6 were included in the qualitative analysis. It may be concluded that Wits and Holdaway H angle are the most meaningful cephalometric parameters in grouping the Angle III patients for camouflage treatment or orthognathic surgery.

Keywords: orthodontic-surgical treatment, orthognatic surgery, camouflage orthodontic treatment, Angle Class III.

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INTRODUCTION

Angle class III jaw relationship means that the mandible is positioned more mesial, according to the maxilla and/or cranial base [1]. Occasionally, when the dental compensation overcame the skeletal imbalance, there is Class I dental relationship on the Class III skeletal base [2].

Existing literature has shown that prevalence of Class III malocclusions varies greatly among and within different populations. The prevalence rate was reported to be about5% in the European population, 13-14% among Chinese and Japanese and the lowest prevalence had the Indian population, about 1% [3].

Class III malocclusions are considered to be one of the most complicated orthodontic conditions to treat [4]. Orthodontic treatment of this type of malocclusion includes three different options: 1) growth modification treatment performed in the pre-pubertal stage, 2) orthognatic surgery combined with orthodontic treatment, 3) camouflage treatment performed after the growth [5].

Chin cup, face mask are useful appliances in early treatment of mandibular prognathism for growing patients [6]. However, some studies showed that many Class III patients need retreatment after early orthodontic treatment because of discrepant maxillary and mandibular growth during the pubertal growth spurt [7,8].For non-growing patients with mild or moderate class III skeletal malocclusion and acceptable facial aesthetics a suitable treatment method is camouflage whose main purpose is to mask the skeletal discrepancy through dental compensations [9]. Regardless the efforts of orthodontists to apply non-surgical treatments, for non-growing patients with severe class III malocclusion orthognathic surgery is required to improve esthetics, facial appearance, function, mastification and speech [10]. Surgical treatment of Class III malocclusion includes mandibular retrusion, maxillary protrusion or a combination of both and it is combined with conventional orthodontic treatment [11].

The main aspects, when choosing which treatment method would have the best outcomes, are age of the patient, severity of the malocclusion, clinical and cepfalometric evaluations and patient's complaints [12]. Kerr et al. claimed that patient with ANB angle lower than -4º and incisor mandibular plane angle lower than 83º should be treated surgically [13], while other authors suggest that Wits is the most useful parameter for assigning patients for different treatment groups [14,15]. In other study, Rabie et al. evaluated patients who had undergone orthognatic surgery or camouflage treatment and found that Holdaway angle can be a major cephalometric parameter, when assigning patients to different treatment groups [16].In a similar study, Eisenhauer et al. suggested that predictive parameters for classification patients in different treatment groups are Wits, length of the anterior cranial base, maxillary/mandibular (M/M) ratio, and lower gonial angle [17].

Since, according to the available literature, there are no general opinion which is the most reliablecephalometric parameter for choosing proper treatment modality in class III cases, therefore the aim of this review was to provide some guidalines which can assist the clinicians in order to determine which variables are indicative of one or other treatment.

MATERIALS AND METHODS

This review was conducted, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations [18].

Selection criteria for the studies

The acronym PICOS (population, intervention, comparison, outcomes, study design) was used to establish primary inclusion criteria for the studies [19].

- Population: adult patients with a skeletal class III malocclusion; intervention: surgical-orthognatic treatment;
- comparison: orthodontic camouflage treatment;
- outcome: dental, skeletal and aesthetic measurements;
- study type: non-randomized clinical trials.

Exclusion criteria were:

- syndroms,
- craniofacial anomalies,
- skeletal asymmetries.

Search strategy

The search includes the following databases: PubMed, Cochrane Library. Before beginning the search in the databases, the search strategy was discussed between two investigators. The study selection was performed independently by two reviewers. The reviewers screened all articles by title and abstract and removed the duplicates. Then reviewed full-text publications to confirm final eligibility criteria. Disagreements were resolved by discussion. The search strategy for PubMed, which was appropriately adapted for each electronic database, was the following: (orthodontic-surgical treatment OR orthognatic surgery), (skeletal class III OR mandibular prognatism OR maxillary retrusion OR angle class III), (camouflage treatment OR non-surgical orthodontic treatment). Different combinations of these terms were considered during the search.

Data extraction

Methodological and statistical data were compiled from the included studies. Any discrepancies were resolved by consensus between the authors.

Protocol

Analysis and inclusion criteria methods were specified in advance and documented in a protocol.

Focus question

The following review question was developed according to the population, intervention, comparison, and outcome (PICO) study design [19]: What are the cephalometric data differences in adult Angle III orthodontic adult patients, selected for camouflage treatment and orthognathic surgery?

Types of publications

The review included all human studies and case reports series published in English. Reviews, letters, editorials and PhD thesis were excluded.

Types of studies

Present review included all retrospective and prospective follow-up studies, case-control studies, case report series and cohort studies published between 2005 and 2020evaluating two different treatment modalities for Angle class III patients.

Types of participants/population

The subjects in the included studies should have been treated for Angle III malocclusion, including camouflage treatment and orthognathic surgery and compared between groups.

Data items

All included studies were arranged according to following fields:

- "Author/year" - to show the author and year of publication.
- "Number of subjects" - evaluated the number of subjects included in studies.
- "Intervention" - showed the treatment types used for the patients.
- ''Cephalometric data" –showed the pre-treatment cephalometric data for both treatment groups.

Risk of bias assesment

The quality of all included studies was evaluated during the full text reading stage. To assess the risk of bias in every study the Cochrane Collaboration's two-part tool was used [20]. If any uncertainties were found in studies, the decision was made through the discussion between the authors.

All the articles were individuallyevaluated to assess the risk of bias in random sequence generation, allocation concealment, blinding of participants and practitioners, blinding of outcomes assessment, incomplete outcomes data, selective reporting and other sources of bias. All the categories were rated as "low risk of bias", if any uncertainties were found, "high risk of bias" if study showed bias in selected category and "unclear risk of bias" if the methodology was not clearly stated and the risk remained questionable. A study itself was mentioned as "low risk of bias", if all the categories were rated for "low risk of bias". If at least one category was rated as "high risk of bias" or "unclear risk of bias", the study itself is rated as "high risk of bias" or "unclear risk of bias" respectively.

RESULTS

Study selection process was graphically designed according to PRISMA flow diagram. (Figure 1)The initial search identified a total of 214. The screening of article titles and independent screening of abstracts resulted in 161 possibly included articles. The inclusion and exclusion criteria were applied to20full-text articles. A total of 6 articles that met the inclusion criteria were selected for systematic review [21-26].

The κ values for inter-reviewer agreement for potentially relevant articles were 1 (titles and abstracts) and > 0.9 (full-text articles), indicating an "almost perfect agreement" between the 2 reviewers [27].

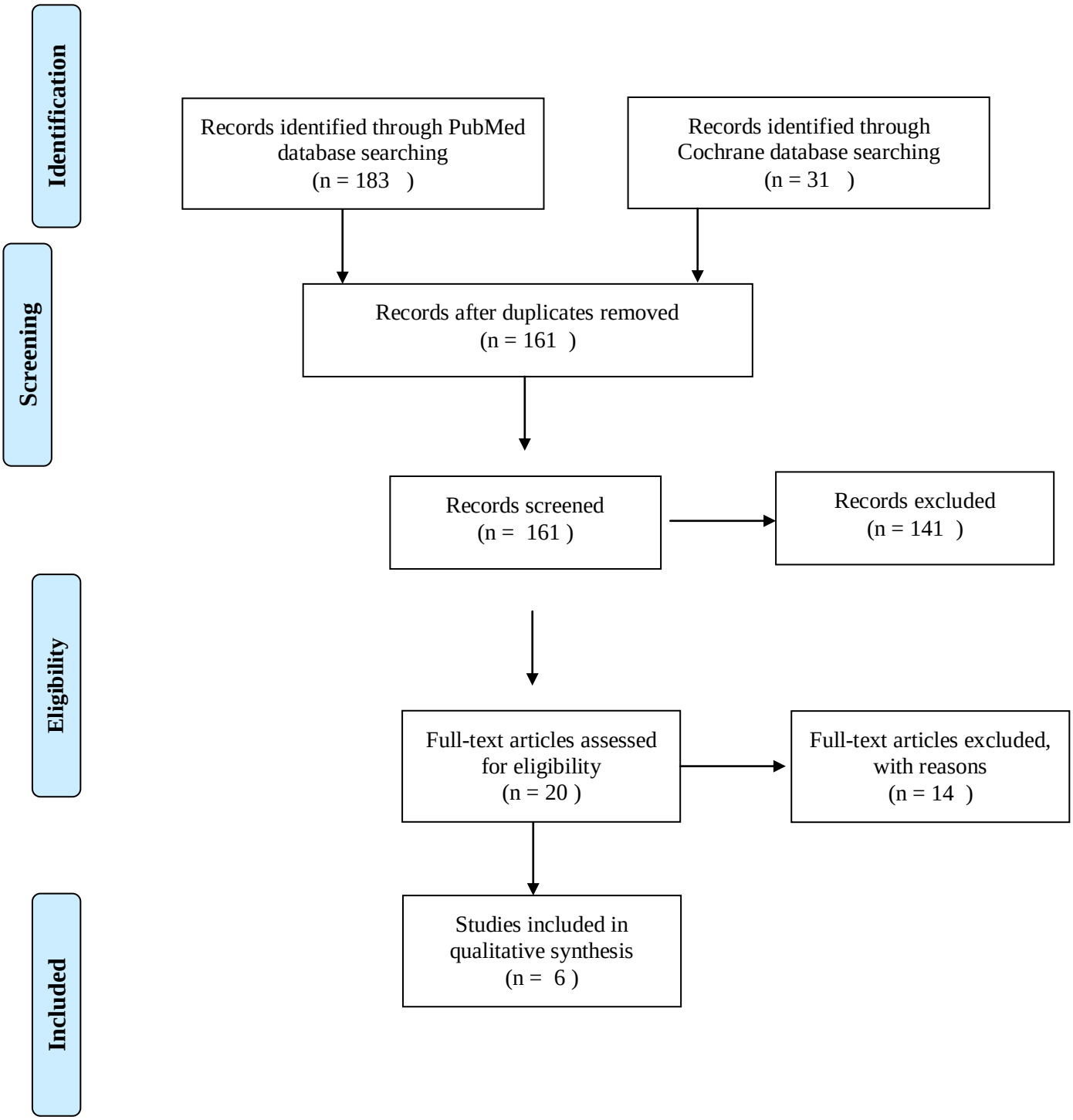

Figure 1. The PRISMA flow diagram.

Risk of bias

In total all 6 studies were considered as "low risk of bias", since all the categories in Cochrane Collaboration's two-part tool were carried out with low possibility of bias [21]

Table 1. Evaluating the Risk of Bias of a study.

	Sequence generation	Allocation concealment	Selective reporting	Other sources bias	Blinding (participants)	Blinding (outcomes)	Incomplete outcome
Eslami et al, 2018	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Rabie et al, 2008	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Xiong et al, 2013	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Martinez et al, 2016	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Troy et al, 2008	**low**	**low**	**low**	**low**	**low**	**low**	**low**
Georgalis et al, 2015	**low**	**low**	**low**	**low**	**low**	**low**	**low**

Some of the limitations may be found in this review that may influence the outcomes. In present review only studies published in English were evaluated. Also, only studies comparing the camouflage treatment vs orthognathic surgery were selected. Also, various heterogeneity across the studies was seen. Also, all the studies included are retrospective, therefore it is impossible to evaluate the possible bias that happened during the selected treatment.

Study characteristics

All of the included studies [21-26] are retrospective studies, that analysed cephalometric data in Angle III patients treated with orthodontic camouflage or orthognathic surgery. In total 431 patients were evaluated among all the studies with 221 (51,28 %) camouflage treatment patients and 210 (48,72%) orthognathic surgery patients.

Table 2. Summary of the studies included in the qualitative analysis.

Author	Study date	Population	Cephalometric data
Eslami et al [21]	2018	65 (36 camouflage and 29 surgery)	Holdaway H angle, Wits
Rabie et al [22]	2008	25 (13 camouflage and 12 surgery)	Go-Me/S-N ratio, U1-L1 angle, and Holdaway angle
Xiong et al [23]	2013	46 (25 camouflage and 21 surgery)	No statistically significant differences
Martinez et al [24]	2016	156 (77 camouflage and 79 surgery)	Wits, lower incisor inclination, inter-incisal angle
Troy et al [25]	2008	72 (39 camouflage and 33 surgery)	L1-GoGn, L1-NB, SNB, ANB, Wits
Georgalis et al [26]	2015	67 (31 camouflage and 36 surgery)	SNB, ANB, Wits, incisal overjet, Pog' to Pog, U1 to NA and L1 to Md plane.

Meaningful cephalometric data

Wits parameter showed statistically significant differences in most studies [21, 24, 25, 26]. Holdaway H angle was mentioned twice [21, 22], same as SNB [25, 26] and ANB [25, 26].

Eslami et al [21] stated that only Wits and Holdaway H angle are suitable for grouping patients to camouflage treatment and orthognathic surgery. The specific equation was designed, which may help in sorting the patients.

$$x = 0.232 + (0.408 \cdot Wits) \cdot (0.199 \cdot Holdaway\ H\ angle)$$

It was found in Eslami et al [21] study, that the centroid x meaning in camouflage group was 0.637 and in orthognathic surgery group -0.077. Without presented equation it was calculated that camouflage treatment is more suitable for those with Holdaway H angle higher than 10.3º and Wits higher than -5.8. Therefore patients with Holdaway H angle lower than 10.3º and Wits lower than -5.8 would have better outcomes with orthognathic surgery.

Martinez et al [24] stated that Wits is the ideal cephalometric parameter in grouping the patients for camouflage or surgical treatment. The mean Wits values for camouflage treatment was -7±1.9 and for surgical treatment it was -11.2±3.2 ($p<0.0001$).

Troy et al [25] and Georgalis et al [26] also showed the same results, comapring Wits parameter between groups. It was found that Wits is lower for those in surgical group than for those in camouflage group. Troy et al [25] evaluated Wits mean as -6.91 for camouflage group and -10.87 for surgical patients group. Therefore Georgalis et al [26] showed similar results with -7.2 for camouflage group and -11.5 for orthognathic surgery group.

Rabie et al [22] stated that despite Go-Me/S-N ratio and U1-L1 angle differences between camouflage and surgery groups, only Haldaway H angle is the key parameter for grouping the patients. It was evaluated that mean Haldaway H angle rates for camouflage group was 14.57º (SD 4.07) and for orthognathic surgery group 10.14º (SD 4.26). The critical score of Holdaway H angle was evaluated to be 12º, which means that patients with higher than 12º could be succesfuly treated only with camouflage.

All the other parameters were described to be more distant from norms in orthognathic surgery group than those in camouflage group. However, none of the other cephalometric parameters were not described as meaningful borderlines for sorting the patients.

DISCUSSION

This systematic review, conducted in accordance with the PRISMA criteria [18], compared cephalometric data differences in Angle III patients selected for camouflage or surgical treatment. Our comprehensive search resulted in the selection of 6 articles. All of the included studies are retrospective cohort studies.The search included two different databases.

This systematic review focused on successfully treated class III patients in order to create guidelines which could be used as a tool when choosing the right treatment choice. Usually, orhognatic surgery is reccomended to non-growing patients with large dentoskeletal discrepancies, while camouflage is mostly chosen for milder discrepancies [28]. Unfortunately, the decision which treatment should be chosen is not always an easy task, because decision should be based on the clinical examination and the cephalometric analysis by assesing amount of sagittal and vertical discrepancy and facial esthetics.

In 1983, Holdaway claimed that systems based only on hard-tissue measurements may produce disappointing results and recommended to approach orthodontic changes from a soft-tissue analysis perspective, making changes only to the point where the best possible soft-tissue profile is established. The Holdaway angle quantifies the protrusion of the upper lip relative to soft tissue profile and it's ideal value is 10° when facial convexity is normal [29]. This angle is independent of the skeletal discrepancy of the bases but it is necessary to keep in mind that esthetics and facial appearance might be more important than occlusion or skeletal discrepancies for class III patients. The results of this study confirmed the importance of Haldway angle in the decision making process which treatment method is better to choose [21,22].

Eslami et al. stated that for patient with Holdaway angle greater than 10,3° is better to choose camouflage treatment, while for patient with a Holdaway angle lower than 10,3° orthognatic surgery is more suitable treatment [21]. In other study, Rabie et al. claimed that camouflage treatment should be chosen for patient whose Holdaway angle is greater than 12°, while patient with Holdaway less than 12° would require orthognatic surgery [22]. In a similar study, Benyahia et al. found that the borderline of Holdaway angle value was 7.2° [30]. Authors stated that a patient with an Holdaway angle above this value can be successfully treated by orthodontics and patient with Holdaway angle lower 7.2° should be treated surgically. The differences between the results of these studies could be because of the different inclusion criteria.

Wits evaluation is a common parameter in cephalometrics to assess maxillo-mandibular skeletal relationship as an adjunct to angle ANB. It is considered as a diagnostic tool when assessing the severity of antero-posterior jaw disharmony [31]. This systematic review showed that Wits is also very meaningful parameter when choosing proper treatment method for Angle class III patients. In Troy et al. [25], Georgalis et al. [26] and Martinez et al. [24]studies, when compared a Wits parameter between groups, found that for camouflage group Wits mean differed from -7.2 to -6.91, while for surgical group it differed from -11.5 to -10.87. In a similar study, Eisenhauer et al. also claimed that Wits value is the ideal parameter when choosing between the camouflage and surgical treatment methods [17].

In order to achieve the most accurate guidelines for the right choice between treatment techniques this systematic review would have included only randomized controlled trials. Unfortunately, in a randomized study, patients would be randomly assigned to orthodontic camouflage or surgical-orthodontic treatment groups and it would not be ethically acceptable. Because the patients have the right to decide which treatment they want to perform. Also, obtaining a control group would be unfair for patients who would have to choose not to undergo any intervention, while knowing that they need treatment.

CONCLUSIONS

Wits and Holdaway H angle are the most meaningful cephalometric parameters in grouping the Angle III patients for camouflage treatment or orthognathic surgery.

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