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Orthodontic Management for Class III Malocclusion

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ABSTRACT

Background: Class III malocclusion influences between 5% and 15% of the population. The 2 most common quandaries encompassing Class III management are the planning of treatment and the type of appliance. Various appliances have been utilized to correct a Class III skeletal discrepancy; however there is little proof accessible on their adequacy in the long term. Additionally, early management of Class III malocclusion has been practiced with expanding interest. Nevertheless, there has been no strong confirmation on the advantages in the long term. **Aim of the study:** we conducted this systematic review to assess the adequacy of orthodontic techniques utilized in the early treatment of Class III malocclusion in the short and long terms. **Methods:** A systematic search was performed in the scientific database independently of language, particularly MEDLINE, EMBASE, the Cochrane Central Register of Controlled Trials, CINAHL, and individual orthodontic journals were searched to November 2016. The selection criteria included randomized controlled trials (RCTs) and prospective controlled clinical trials (CCTs) of children between the ages of 7 and 12 years on early treatment with any type of orthodontic/orthopaedic appliance compared with another appliance to correct Class III malocclusion or with an untreated control group. The primary outcome measure was correction of reverse overjet, and the secondary outcomes included skeletal changes, soft tissue changes, quality of life, patient compliance, adverse effect, Peer Assessment Rating score, and treatment time. **Results:** Ten studies, 6 RCTs and 4 CCTs, are involved in this review. In the RCT group, only 2 of 6 studies were assessed at low risk of bias, and the others were at high or unclear risk of bias. All 4 CCT studies were classified as high risk of bias. Two RCTs involving 109 participants looked at the comparison between protraction facemask and untreated control. The results for ANB angle (mean difference, 3.40; 95% CI, 2.6-3.15; P <0.0001) and reverse overjet (mean difference, 2.5 mm; 95% CI, 1.21-3.79; P< 0.0001) were statistically significant favouring the facemask group. All CCTs validated a statistically significant advantage in favour of the use of each appliance. Nonetheless, the studies had high risk of bias. **Conclusions:** There is a moderate amount of evidence to show that early treatment with a facemask results in positive improvement for both skeletal and dental effects in the short term. Though, there was absence of evidence on long-term benefits. There is certain evidence regarding the chin cup, removable mandibular retractor, and tandem traction bow appliance; however the studies had a high risk of bias. Additional high-quality, long-term studies are assessing to evaluate the early treatment effects for Class III malocclusion patients.

Keywords: Class III malocclusion, orthodontic management, risk of bias, Facemask, chin cup.

INTRODUCTION

Early management of Class III malocclusion has been endeavoured with differing achievement. The primary preferred standpoint of early treatment Class III malocclusion is to prevent surgical interference and therefore decrease the morbidity of the surgery [1]. The planning of early treatment is critical for an effective result. Some studies have reported that treatment ought to be carried out in patients less than 10 years of age to improve the orthopaedic impact [2, 3]. Conversely, different examinations have discovered that patient age had little impact on treatment response and result [4, 5]. Therefore, there is no solid proof to help that early management would be beneficial. The principle objectives of early involvement are to offer a more favourable environment for growth and to develop the occlusal relationship such as facial esthetics and correcting the crossbite [6]. Many orthopedic appliances have been investigated including protraction facemask, removable mandibular retractor, class III elastics, reverse Twin-block, FR-3 appliance of Frankel, bionator, chincup, double-piece corrector, and mandibular headgear to attain this aim. Between these, the protraction facemask is favoured by many to correct a retronagthic maxilla. Alternatively, the chincup is believed to retard or redirect the growth of a prognathic mandible. The previous Cochrane systematic review determined that even though there was some indication for the effectiveness of the facemask appliance in the short term, there is no indication that the outcomes are preserved in the long term [7]. When there are not many high-quality RCTs in the literature, it is

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suitable to look at prospective controlled clinical trials (CCTs). Moreover, additional randomized studies have been published since the review. Hence, this review is to update the Cochrane review and furthermore to incorporate planned CCTs to assess the confirmation base for Class III early treatment. The goal of this systematic review is to assess the effectiveness of orthodontic methods used in the treatment of Class III malocclusion in the short and long terms.

MATERIALS AND METHODS

Data sources and search terms

A systematic search was performed in the scientific database independently of language, particularly MEDLINE, EMBASE, the Cochrane Central Register of Controlled Trials, CINAHL, and individual orthodontic journals were searched to November 2016. The selection criteria included randomized controlled trials (RCTs) and prospective controlled clinical trials (CCTs) of children between the ages of 7 and 12 years on early treatment with any type of orthodontic/orthopaedic appliance compared with another appliance to correct Class III malocclusion or with an untreated control group. The primary outcome measure was correction of reverse overjet, and the secondary outcomes included skeletal changes, soft tissue changes, quality of life, patient compliance, adverse effect, Peer Assessment Rating score, and treatment time.

Study selection and criteria

The selection criteria for considering studies for this review were the following:

1. Types of studies: RCTs and prospective CCTs
2. Participants: studies of subjects with Class III malocclusion between 7 and 12 years of age
3. Intervention: orthodontic treatment with a removable or fixed orthodontic/orthopedic appliance for early correction of Class III malocclusion
4. Comparison: no treatment, delayed treatment, or intervention with the same appliance with different forces, different mechanics, or a different appliance
5. Primary outcome: correction of reverse overjet (measured in millimeters or by other index of malocclusion) with the measurements based on study models, or cephalometric or clinical assessment.

Secondary results were skeletal changes, quality of life, soft tissue changes, Peer Assessment Rating score, patient compliance, adverse effects, and treatment time.

Data items and gathering

A customized data gathering form was produced and used to gather data from the selected studies. This data involved authors, year of publication, time of treatment, details of the interventions, features of participants, details of the trial, , and outcome measures. The data extraction was performed by both authors individually and in duplication. A challenge to contact the authors was made for any missing information.

The data were gathered and classified according to the study methodology into two categories: RCT and CCT. Data gathering was done without missing data from the eligible studies amid the review. If there were any missing data, an attempt was made to contact the original author. Clinical heterogeneity was measured by exploratory the participant types, involvements, and results. Statistical heterogeneity amid the trials was evaluated by chi-square test where a P value of 0.1 was considered as significant heterogeneity. The I^2 test was similarly carried out. The studies with more than 50% I^2 were evaluated as having significant heterogeneity. Random effects were carried out with high levels of clinical or statistical heterogeneity, and fixed affects when the heterogeneity was low.

The study was done after approval of ethical board of King Abdulaziz university.

Results

A total of 174 records were identified from the initial search. A further search was carried out in November 2016. From the records that were acknowledged, 18 full-text articles were retrieved for further evaluation [8] (Fig 1). Eight articles were subsequently excluded with reasons for exclusion. A total of 10 articles— 6 RCTs6 [9-14], and 4 CCTs [15-18] were included in the final analysis.

Two studies looked at comparisons between facemask and untreated control [9-11]. Only Mandall et al [10, 11] followed up the outcomes achieved by facemask treatment for 15 months and 3 years. The other study evaluated the short-term outcomes [9]. Changes in ANB were the only outcome evaluated by the studies. Mandall et al [10, 11] likewise evaluated the correction of reverse overjet, Piers-Harris concept scores, and OASIS. Facemask studies showed positive results in both skeletal and dental variables. For the changes in ANB, a meta-analysis was performed for the 3 studies. The pooled estimate was 3.40 (95% CI, 2.6-3.15; P <0.0001). It was statistically significant and favoured the facemask group. However, the I2 year or month? for heterogeneity was high (82%). For overjet, only Mandall et al [10, 11] stated the result at 3 years. Analysis showed a statistically significant dissimilarity for the result (2.5 mm, 2.5 mm; 95% CI, 1.21-3.79; P 5 0.0001)

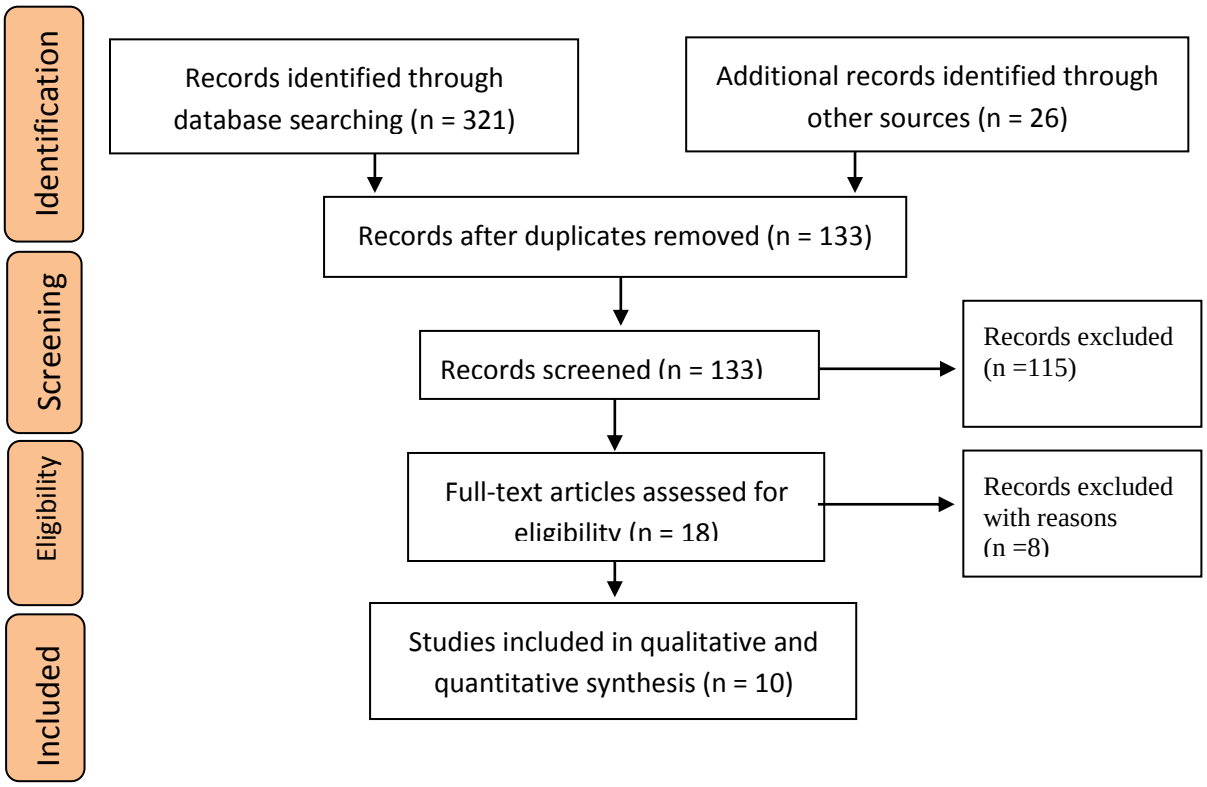

Figure 1: flow diagram showing the selection criteria of assessed studies[22].

Table 1: Characteristics of included RCTs

Authors	Year	Country	Age	Exclusion criteria	Inclusion criteria	Outcomes
Vaughn et al. [9]	2005	United States	Group 1: 7.83 years Group 2: 8.10 years Group 3: 6.62 years	Any craniofacial anomaly, psychosocial impairment, or skeletal open bite	Zero or negative overjet on 2 or more incisors and Class III molar relationship with mesiobuccal cusp of maxillary permanent first molar distal to buccal groove of mandibular permanent first molar, or mesial step terminal plane relationship of 3.0 mm or more if deciduous molars were present (measured clinically)	Skeletal changes: ANB

Mandall et al .[10,11]	2010-2013	UK	Group 1: 8.7 years Group 2: 9.0 years	1. Nonwhite origin 2. Cleft lip/ palate or craniofacial syndrome 3. Previous history of TMJ signs or symptoms 4. Lack of consent	1. Age 7 -9 years old at registration 2. Three or 4 incisors in crossbite in intercuspal position 3. Clinical assessment of Class III skeletal problem	1. Skeletal changes: ANB 2. Reverse overjet 3. Self-esteem (Piers Harris) and OASIS scores 4. TMJ problem 5. PAR score
Keles et al. [12]	2002	Turkey	Group 1: 8.58 years Group 2: 8.51 years	functional Class III	1. Healthy patients without any hormonal or growth discrepancy 2. Anterior crossbite with Class III molar relationship 3. True Class III patients (pseudo or functional Class III patients excluded) 4. Class III patients with maxillary retrognathism were selected for treatment.	Skeletal changes: ANB All measurements were taken before and after treatment on lateral cephalograms
Liu et al. [13]	2015	China	Group 1: 9.8 years Group 2: 10.1 years	1. Previous orthodontic treatment 2. Other craniofacial anomalies, such as cleft lip and palate 3. Maxillary dentition unsuitable to bond hyrax expander	1. Age 7-13 years before treatment with midface soft tissue deficiency 2. Fully erupted maxillary first molars, Class III malocclusion, and anterior crossbite 3. ANB less than 0, Wits appraisal less than -2 mm (corrected cephalometric tracing technique applied for patients with functional shift), and distance from Point A to nasion perpendicular less than 0 mm	Skeletal changes All measurement taken before treatment and when positive overjet with Class I or Class II molars were achieved

Abdelnaby and Nassar [14]	2010	Egypt	Group 1: 9.6 years Group 2: 10.1 years Group 3: 9.2 years	Not reported	1. Patients with skeletal Class III (ANB <1) 2. Mandibular prognathism (SNB >80) 3. Anterior crossbite	Skeletal changes: ANB All measurements taken before treatment and after 1 year
Atalay and Tortop [4]	2010	Turkey	Group 1: 8.18 years Group 2: 11.75 years Group 3: 7.90 years	1. Congenitally missing teeth or congenital syndromes 2. Previous orthodontic treatment	1. Angle Class III malocclusion with anterior crossbite. 2. Skeletal Class III (ANB <0), due to maxillary retrusion or a combination of maxillary retrusion and mandibular protrusion 3. Optimum SN/GoGn angle (between 26 and 38) 4. Fully erupted maxillary incisors 5. No congenitally missing teeth or congenital syndromes such as a cleft lip/palate	1. Dental changes: overjet 2. Skeletal changes: ANB All measurements taken before and after treatment

Table 2: Characteristics of the included CCTs

Authors	**Year**	**Country**	**Age**	**Exclusion criteria**	**Inclusion criteria**	**Outcomes**
Cozza et al. [15]	2010	Italy	Treatment group: 8.9 years Control group: 7.6 years	Not reported	1. Class III malocclusion in the mixed dentition characterized by Wits appraisal of –2 mm or less, anterior crossbite or incisor end-to-end relationship, and Class III molar relationship 2. No permanent teeth were congenitally missing or extracted before or during treatment 3. No transverse discrepancy between the dental arches	Dental changes: reverse overjet Skeletal changes: ANB

Barrett et al .[16]	2010	Italy	Treatment group: 8.5 years Control group: 7.3 years	Not reported	Occlusal signs of Class III malocclusion with Wits appraisal of –2 mm or more	Dental changes: reverse overjet Skeletal changes: ANB
Kajiyama et al. [17]	2004	Japan	Treatment group: Deciduous dentition: 5 y 6 mo Mixed dentition: 8 y 7 mo Control group: not reported	Not reported	1. Anterior crossbite (negative overjet) 2. Class III deciduous canine relationship 3. Bilateral mesial step type of terminal plane or Class III permanent molar relationship 4. No craniofacial anomalies (cleft lip or palate) 5. No previous orthodontic treatment	Skeletal changes: ANB
Kajiyama et al. [18]	2000	Japan	Treatment group: 8 y 7 mo Control group: 8 y 1 mo	History of orthodontic treatment	1. Anterior crossbite (negative overjet) 2. Stage III-B of Hellman's developmental stages (4 maxillary and mandibular incisors have erupted) 3. Angle Class III molar relationship 4. No previous orthodontic treatment	Dental changes: correction of the reverse overjet in angular measurement Skeletal changes: ANB

Mandall et al [10, 11] similarly evaluated self-esteem using the Piers-Harris concept scores and OASIS. No statistically significant differences were found at 15 months (MD, 1.5; 95% CI, -0.96-3.96; P 5 0.23) and at 3 years (MD, 0.6; 95% CI, -2.57-3.77; P 5 0.71) for the Piers-Harris score. Conversely, for the OASIS, there was a significant difference at 15 months with -4.00 (95% CI, -7.40 to -0.60; P 5 0.02) in favour of the control group. However, there was no difference in the results for the 3- year follow-up (MD, 3.40; 95% CI, -7.99-1.19; P 5 0.15). Atalay and Tortop [4] compared the tandem traction bow appliance with an untreated control. There was strong evidence in favour of the tandem traction bow appliance in both measured outcomes: ANB changes (MD, 1.7; 95% CI, 1.54-1.86; P <0.001) and overjet correction (MD, 3.30 mm; 95% Cl, 3.08- 3.52; P<0.001). The evidence favoured the use of the appliance for changes of A point (MD, 1.47; 95% CI, 1.20-1.74; P<0.00001) and B point (MD, 1.87; 95% CI, -2.03 to -1.71; P <0.001).

DISCUSSION

The facemask studies indicated positive corrections in the skeletal and dental variables. Though, due to the high heterogeneity in the pooled studies, the indication was classified as moderate. Excitingly, we found no standardized design of the facemask for Class III treatment or a standardized result technique for evaluating the effect of the appliance. The variations in the design of the facemask appliance used are discussed below.

Mandall *et al.* [10, 11], Liu *et al* .[13], Keles *et al.* [12], and Vaughn *et al* .[9] used fixed rapid maxillary expansion devices, **Cozza *et al.* [15]** used fixed buccal and palatal arches, and Xu and Lin [18] and Showkatbakhsh et al [19] used removable appliances. The direction of force was practically reliable in the

studies of **Vaughn *et al.*** [9]**,Liu *et al.*** [13]**, Mandall *et al.*** [10, 11]**, Keles *et al* .**[12]**, and Cozza *et al.*** [15] using about 30 of downward and forward force. The other studies did not identify the direction of force application. The force applied different between 300 and 600 g. **Cozza *et al.*** [15, 20] used 600 g in their 2010 study and 400 g in their 2004 study, respectively. **Mandall *et al*** [10, 11] and Vaughn et al [9] used about 400 g; Keles et al [12] used 500 g, and Liu et al [13] used between 400 and 500 g of force.

The quality of indication in the studies looking at the chin cup, modified maxillary protractor, tandem traction bow appliance, maxillary protraction bow appliance, and tongue plate was considered to be low. Though the results were positive in terms of skeletal and dental changes, the high risk of bias made the positive results questionable. **Mandall *et al.*** [10, 11] included hooks near the center of rotation of the maxilla, **Vaughn *et al.*** [9] added hooks mesial to the canines, and **Keles *et al.*** [12] placed the hooks distal to the canines. Liu et al [13] positioned hooks around the canine area, and **Cozza *et al.*** [15, 20] added hooks near the first molar area. All encompassed studies concentrated only on the short-term treatment outcomes, with a lack of long-term follow-up. Generally, the orthodontic management for a patient with Class III skeletal issue is to defer management until the patient passes the growth phase, since we are aware that if treatment is provided early, further growth will undo the good done by the early treatment and, in the worst case, compromise additional orthognathic treatment. In short, the short-term favourable outcomes are not conclusive and robust to allow any recommendation and estimation of the long-term treatment effects attained by the appliances.

Skeletal changes in Class III treatment are constantly the main effort of studies and were largely specified as values for ANB angle and the Wits appraisal. For the facemask appliance, the reported ANB changes ranged from 2 to 5. On the other hand, the chincup studies displayed a smaller range of changes from 0.3 to 2.5. However, no long-term data are obtainable. For the other appliances, as a consequence of the small sample sizes and poor study quality, it is not possible to make any conclusion. When the data for the SNA and SNB angles were looked at descriptively for treatment groups, the facemask produced development in both SNA and SNB regularly, while the chin cup mainly worked on restraint of mandibular growth (SNB) (Table 3). Though, the data for the chin cup were derived from just one study.

Table3. SNA and SNB changes for treatment groups in RCTs

Study	Groups	SNA mean (SD)	SNB mean (SD)
Vaughn et al [9]	A = FM with expansion	2.77	-1.06
	B = FM no expansion	2.51	-1.43
Mandall et al [10,11]	A = FM	2.3 (2.1)	0.8 (1.5)
Abdelnaby and Nassar [14]	A = chin cup with occlusal biteplate 600-g force	0.3 (0.47)	-2.2 (0.41)
	B = Chin cup with occlusal biteplate 30-g force	0.4 (0.5)	-2.0 (0.79)
Atalay and Tortop [4]	A = modified tandem traction bow-early treatment	0.7 (0.28)	-1.1 (0.32)
Liu et al [13]	A = FM with expansion	1.93 (0.79)	-2.35 (1.21)
	B = FM with expansion/constriction	2.67 (1.31)	-1.49 (0.89)

The valuation of quality of life in Class III management was evaluated by Mandall et al. [10, 11] they determined that management does not seem to confer a clinically important psychosocial benefit. It is not unexpected for the reason that, while the skeletal changes were statistically important, they were only a few degrees, which may not be significant enough for patients to appreciate. The pervasiveness of Class III malocclusion differs extensively between different areas and ethnic groups. It has been stated to be as low as 5% in European countries **[21, 22].** Funding bodies are biased to studies that make the most impact, and it is improbable that they will fund for diseases with rare incidences. This makes it difficult to acquire big research funding in orthodontics, particularly when competing with medical diseases such as cancer and diabetes studies.

CONCLUSION

An important factor for treatment of Class III malocclusion in growing patient is the origin of malocclusion. The skeletal or dental origin of the malocclusion and in skeletal Class III malocclusions mandibular prognathism or maxillary deficiency is important for choosing early intervention and

selection of the appliance for treatment. There is certain evidence regarding the chin cup, removable mandibular retractor, and tandem traction bow appliance; however the studies had a high risk of bias. Additional high-quality, long-term studies are assessing to evaluate the early treatment effects for Class III malocclusion patients.

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