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Review Article

Treatment effects of posterior bite blocks for correction of skeletal anterior open bite in growing patients. A systematic review

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Abstract

Objective: Posterior bite blocks (PBB) are commonly used to treat anterior open bite in mixed dentition to take advantage of the active growth for producing faster and more stable results. PBB impedes posterior teeth eruption and their design has been continuously modified. The present review aims to bring information on the effectiveness of different types of bite blocks for an open bite in growing patients.

Materials and Methods: An electronic search of 4 databases was performed from January 1, 1985 to July 30, 2021. Studies were considered for inclusion if they reported on open bite samples that underwent orthodontic treatment in the mixed dentition. Records were required at the initial and posttreatment times. Hand-searching of reference lists of the included studies was performed. The methodological quality of individual selected studies was done using the risk-of-bias assessment tool as elaborated in Cochrane Handbook for Systematic Review of Interventions (version 5.4.0).Result: The search strategy resulted in 467 articles. After selection according to the inclusion/exclusion criteria, 5 articles qualified for the final review analysis. The qualified articles include 5 RCTs. A total sample of 137 patients was analyzed in analysis with ages ranging from 7 to 14 years.

Conclusion: Although the quality of evidence for treatment of open bite with bite block and its modification is not high, all included five studies reported both dental and skeletal correction of open bite. Prospero registration no. CRD42021270606.

Keyword: Anterior open bite, Posterior bite block, Growing patient, Bites, Open bite, Magnetic bite block, Spring loaded bite block

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1. Introduction

Open bite is a vertical discrepancy with a lack of contact between the maxillary and mandibular dental arches. The open bite may be anterior, posterior, or lateral and a combination of both.[1] Lateral open bite is seldomly seen,[2] while the anterior open bite is often reported. The prevalence of anterior open bite in US children was reported as 3.5% in the white and 16.5% in the black population.[3] Proffit et al recorded a prevalence of approximately 3.5% in patients from eight to 17 years of age.[4]

Open bite develops because of the interaction of many etiologic factors, both hereditary and environmental.[1] The major causes of an anterior open bite are forces that result from thumb or finger sucking, pacifier use; lip and tongue habits; airway obstruction; inadequate nasal airway creating the need for an oral airway; allergies; septum problems and blockage from turbinates; enlarged tonsils and adenoids; and skeletal growth abnormalities.[5]

The open bite may have dental, skeletal, and both dental and skeletal components. Dental open bite is the result of a mechanical blockage of the vertical development of the incisors and the alveolar component while skeletal relationships are normal; the skeletal open bite is determined by a vertical skeletal discrepancy.[6] Skeletal open bite is characterized by increased lower anterior facial height and gonial angle, short mandibular ramus, and increased posterior dentoalveolar height. Concomitant transverse discrepancies may also be present.[8]

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If skeletal open bite is reported early in the mixed dentition period, it has to be treated simultaneously to take advantage of active growth for producing faster and more stable results and to reduce the burden of treatment in the permanent dentition.[11-13]

An open bite can be treated either by extrusion of the anterior teeth, which is often unsatisfactory due to a poor aesthetic result, or intrusion of the posterior teeth, resulting in autorotation of the mandible anteriorly.[14]

A series of treatment approaches reported in the literature regarding early treatment of open bite. These treatment modalities include mainly functional appliances [24-29,] headgears,[22-23], and bite blocks.[14-21,39] Extractions and mesialization of posterior teeth have been advocated by reduced open bite.[30] Palatal cribs and spurs are used to intercept persisting sucking habits or tongue thrust to promote normal anterior segment development.[31-35]

A skeletal open bite can be treated by growth modification with the use of a posterior bite block. Posterior bite blocks hinder posterior teeth eruption and their design has been continuously modified. They can be made of wire or plastic to fit between the maxillary and mandibular teeth, or they can be spring-loaded or fitted with magnets, etc.[14-21]

The present review aims to bring information on the effectiveness of the different types of bite blocks for management of an open bite in growing patients.

2. Materials and Methods

2.1. Protocol development and registration

This review was conducted according to preferred reporting items for systematic review and meta-analysis statements.[40] The following focused question in patient, intervention, comparison, and outcome (PICO) format was posed “are posterior bite blocks and its modifications (I) effective in decreasing vertical dimension of the face (O) during the management of open bite in growing patients (P)?.

2.2. Search strategy

An electronic search without the restriction of language was conducted on PubMed, MEDLINE, and Cochrane library. Searches in the ClinicalTrials.gov database and references of included studies (cross-referencing) were also conducted with Google Scholar. In addition to electronic search, a hand search was made, and reference lists of selected articles were screened. The search strategy was based on National Health Service Center for Reviews and Dissemination guidelines.[41] The following orthodontic journals were hand-searched: *American Journal of Orthodontics and Dentofacial Orthopedics, Angle Orthodontist, European Journal of Orthodontics, Journal of Orthodontics, and Orthodontics and Craniofacial Research*. Medical subject headings (MeSH) terms, keywords, and other free terms related to PICO questions were used along with Boolean operators like OR, AND to combine searches. The same keywords were used for all search platforms followed the syntax rules of each database. The following keywords were used: anterior bite block, posterior bite block, growing patients, molar intruders.

2.3. Selection criteria

The Inclusion criteria were

Population (P): Anterior open bite patients. Steep mandibular plane angle (SN-MP) exceeding 36 degrees. No record of sucking habits in recent years and anterior open bite was either unchanged or increased in the last 6 months.

Interventions (I): Posterior bite block and its modifications

Comparison (C): Not relevant

Outcome (O): Changes in overbite in millimeter (mm), Linear and angular changes in the vertical dimension of face assed using cephalometric measurement**.**

Study design (S): Randomized controlled trials

The exclusion criteria were

Patients with craniofacial syndromes and/or cleft lip palate, temporomandibular joint disorders, sucking habits, orthodontic treatment of anterior open bite with treatment modalities other than posterior bite block, animal Studies, letter to the editor, interviews, commentaries, abstracts, summaries, cross-sectional surveys and studies with a treatment plan including corrections of sagittal section.

2.4. Screening process

The search and screening, according to the previously established protocol were conducted by two authors. A two-phase selection of articles was conducted. In phase one, two reviewers reviewed titles and abstracts of all articles. Articles that did meet inclusion criteria were excluded. In phase two, selected full articles were independently reviewed and screened by the same reviewers. Any disagreement was resolved by discussion. When the mutual agreement between two reviewers was not reached, a third reviewer was involved to make a final decision. The final selection was based on consensus among all three authors.

2.5. Data extraction

A data extraction protocol was defined and assessed by two authors. Abstracts identified from searches were screened by two independent reviewers. Both independent reviewers reviewed full-text version of articles and articles were retained after meeting inclusion criteria. The agreement on inclusion and exclusion assignment was unanimous. The data were extracted independently from full-text articles selected for inclusion, using a standardized form in electronic format. The following data were extracted from included studies: author, year of study, sample size, mean age of the participants, types of intervention, comparator, outcome,

design of primary studies or the study design, main results, and conclusion. The corresponding authors of the study were contacted via email where further information was required.

2.6. Assessment of the methodological quality

The methodological quality among included studies was executed by using the Cochrane collaboration tool for RCTs through their domains: random sequence generation, allocation concealment, blinding of participants, incomplete outcome data, selective reporting, and other biases; through their signalling questions in Review Manager (RevMan) 5.3 software. The overall risk for individual studies was assessed as low, moderate, or high risk based on domains and criteria. The study was assessed to have a low overall risk only if all domains were found to have low risk. The high overall risk was assessed if one or more of the six domains were found to be at high risk. A moderate risk assessment was provided to studies when one or more domains were found to be uncertain, with none at high risk.

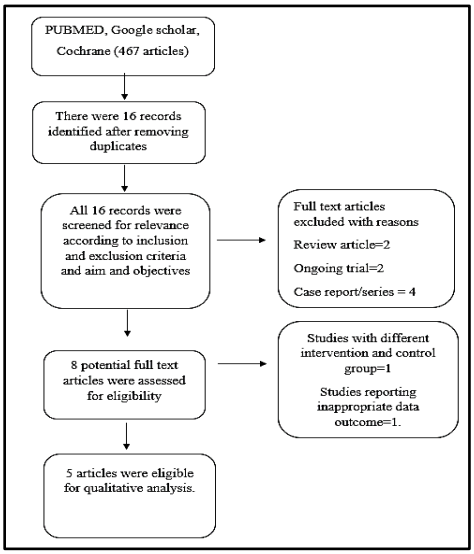

Figure 1:

3. Result

The initial electronic database search on PubMed/MEDLINE and Cochrane library resulted in 467 articles. After removal of duplicates and screening of abstracts, 16 relevant articles were selected by two independent reviewers according to inclusion, exclusion criteria, aim, and objectives. After pre-screening, application of PICOS questions, eight articles were selected for full-text accessibility. Of selected eight articles, two articles were removed with different interventions and outcomes and with inappropriate data outcomes. Finally, only six articles were eligible to be included for qualitative synthesis as shown below in

3.1. Study characteristics

There are five studies[14,15,17,20,39] included in this review and the general descriptive characteristics of which are presented in **Table 1**. Five studies[14,15,17,20,39] had a randomized controlled trial as study design. A total sample of 137 patients was analyzed in analysis with ages ranging from seven to fourteen years. Among the included studies, one study[14] was conducted in Sweden, one study[15] in Switzerland, one study[17] in Turkey, one study[20] in India, and one study[39] in the USA.

The study design was randomized controlled trial in all included studies[14,15,17,20,39]. All studies [14,15,17,20,39] reported the same outcome of a reduction in open bite and vertical dimension. All included studies[14,15,17,20,39] utilised same method or measurement of cephalometric analysis. Among included studies, two[14,17] studies used posterior bite block as intervention, three studies [14,15,20] used magnetic bite block, two studies[15,20] used spring-loaded bite block and one study[39] used active vertical corrector.

Table 1: Summarized data of the six studies included in the review.

	Study	Design	Setting	Characteristics of patient	Intervention	No. of patients (M/F)	Methods /measurement	Ages in years (SD)	Treatment time (m)	Outcome	Side effects
1	Kiliaridis Set al [14]	RCT	University of Goteborg ; Sweden	Anterior open bite, no record of sucking habit in recent year	MMB PBB	10 MBB 10 PBB	Cephalometric analysis	8.9-16.1	18 hours daily for 6 months	Reduction in open bite and vertical dimension of the face	Lateral cross bite with MBB

2	Barbre RE et al [39]	RCT	University of North Carolina	Anterior open bite with high mandibular plane angle	AVC	25	Cephalometric analysis	8.3-13.5	7.7	Reduction in open bite and vertical dimension of the face	No side effects
3	Kuster R et al [15]	RCT	University of Bern, Switzerland	Anterior open bite	SLBB MBB	22(11/11) SPSS 11(4/7) MBB	Cephalometric analysis	7.5-11.7SPBB 9.9-14.5MBB	12 SLBB 3 MBB	Reduction in open bite and vertical dimension of the face	No side effects
4	Iscan HN et al [17]	RCT	Gazi University, Turkey	Anterior open bite, Anterior open bite SN-MP≥37º ANB 2º-8º	TG1:5 mm PBB TG2:10mm PBB	13(4/9) TG1, 12(3/9) TG2, 14(3/11)	Cephalometric analysis	TG1:8.9-13.5 TG2:8.7-14.5 Crt:8.9-13.3	18 hours per day For G1:4-10, G2:4-13 Crt:7-9	Reduction in open bite and vertical dimension of the face	No side effects
5	Doshi UH et al [20]	RCT	Maharashtra University of health sciences, India	(1) Anterior open bite on clinical inspection (incisor overbite: <−1.0 mm), (2) SN-MP angle >40º), gonial angle (>137°), (3) Class I or II occlusion	TG1: SLBB TG2: MBB	TG1:10(5/5) TG2:10(3/7)	Cephalometric analysis	8-13	8	Reduction in open bite and vertical dimension of the face	No side effects

PBB-Posterior bite block; SLBB -Spring-loaded bite block; MBB- Magnetic bite block; AVC- Magnetic active vertical corrector; RCT-Randomized Clinical Trial; TG-Treatment Group; Crt-Control group.

3.2. Assessment of the methodological quality

The methodological quality among the individual selected studies was done using the risk-of-bias assessment tool as elaborated in Cochrane Handbook for Systematic Review of Interventions. The results are depicted in (**Figure 2**) as the risk of bias graph and summary respectively which were generated using the RevMan software (v5.3). There are six domains under which the methodology of individual studies is assessed and granted a level of risk. The quality assessment of the included five studies were done with representation (**Figure 3**).

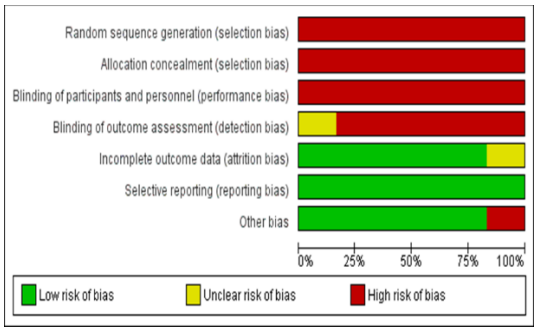

Figure 2: Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

A large variation of 100% was seen among included studies concerning random sequence generation and allocation concealment. While all studies[14,15,17,20,39] reported a low risk of bias concerning the selective reporting domain.

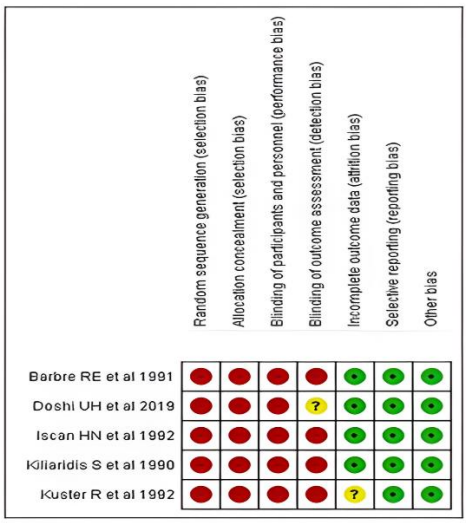

Figure 3: Risk of bias summary: review authors' judgments about each risk of bias item for each included study

All studies [14,15,17,20,39] reported a high risk of bias concerning random sequence generation, allocation concealment, blinding of personnel and participants, blinding of the outcome, incomplete outcome data, and selective reporting. Only two studies[15,20] reported an unclear risk concerning blinding of outcome and incomplete data as data were insufficiently reported by authors.

4. Discussion

This review included data from 5 RCTs involving 137 patients of age between 7-15 years. The included studies in this review used PBB and its modifications as SLBB, MBB, etc. Patients of the included study were treated for an average of 6-9 months with PBB and its modifications which were used 18 hours a day. The cephalometric data was used to assess changes in open bite and vertical dimensions of the face after being treated with PBB and its modifications. It is seen that the effects of PBB and its modification are more pronounced on dentition, with a considerable amount of intrusion of posterior teeth and a small amount of passive eruption of anterior teeth.

Kiliaridis S. et al[14] compared the effects of repelling magnets on the treatment of anterior open bite versus the effects of acrylic posterior bite-blocks. The effect of treatment with magnets was a quick response in the dental and skeletal vertical relationship. In all growing individuals, the open bite was observed to close within less than 4 months, especially in patients in early mixed dentition. In these individuals, the treatment caused improvement of vertical overbite having range from 2.5 to 4.5mm. The intrusion of posterior teeth caused autorotation of the mandible which could be observed in a decrease in lower anterior facial height, in angle between mandibular and palatal planes, and ANB angle.

The Bite-block group showed improvement in dental vertical relation, in those who had used appliance intensively. The range of vertical overbite correction in younger individuals was from 1.5 to 3 mm. The lateral cephalograms of patients with PBB showed similar skeletal changes to those which occurred with the use of magnets.

The disadvantage of bite-block was that its treatment effect declines with time, possibly due to a decrease in forces applied to antagonist teeth by elevator muscles of the jaw.

The bite-block had an advantage as the force was applied principally in the vertical direction, whereas with repelling magnets additional lateral forces were developed. The direction of these lateral forces was dependent upon mandibular lateral movements and resulted in transverse problems. The unilateral cross-bite was occurred in half of the subjects and followed by a tendency towards the full development of the scissor-bite on the opposite side.

Barbre R.E. et al[39] evaluated the treatment effects of magnetic active vertical corrector (AVC) used to treat anterior open bites in growing patients. AVC included samarium cobalt magnet embedded in posterior bite blocks.

This study concluded that AVC therapy produced an average of 3mm of anterior open bite closure over an eight months treatment period. A small amount of mandibular bite closing rotation and a decrease in lower anterior facial height was seen. There were minimal skeletal changes in the sagittal direction attributable to AVC therapy. Kuster R et al[15] studied the effects of treatment of skeletal open bite with two types of bite-blocks.

The effects of treatment on the bite and facial morphology were less marked in the group with SLBB than in the group with MBB, with an average improvement of overbite of 1.3 mm with SLBB and 3 mm with MBB. The mandibular rotation was a result of the intrusion of upper and lower posterior teeth and possibly also increased mandibular growth. No adverse effects of bite-blocks were seen.

Iscan HN et al[17] compared the effects of passive posterior bite-blocks with different construction bites on craniofacial and dentoalveolar structures.

The effects of passive posterior bite-blocks (PPBB), constructed in two different heights (5 mm and 10 mm), were investigated. Increasing height of posterior bite-block was not significantly more effective during the experimental treatment time for overbite production. The growth of the mandible in sagittal direction was increased by increasing height of posterior bite-block. Increasing height of posterior bite-blocks increased gonial angle.

Doshi UH et a[l20] evaluated the effects and long-term stability of open bite correction with spring-loaded and magnetic bite block. Clinically, 5 years after treatment with no retention for 4.2 years, a slight decrease in overjet and

increase in overbite were seen in 12 patients. Stability for both groups was remarkably similar, suggesting effect of bite block may be more important than the addition of active elements such as springs and magnets.

The studies approved in this systematic review have a high risk of bias, which gives an idea of the limitation of this systematic review and contain significant amount of clinical heterogeneity due to the difference in the posterior bite blocks devices used to correct anterior open bite. Some articles added magnets as a modification to the bite blocks while others used springs or they applied bite blocks with different thickness. This heterogenicity of used bite blocks may produce discrete date therefore meta-analysis is not conducted for this review.

5. Conclusion

There are five RCTs for the treatment of bite block and its modification with a high risk of bias. All included five studies reported both dental and skeletal correction of open bite. Only one study mentioned the stability of treatment results. For getting reliable scientific evidence, RCTs with sufficient sample sizes are needed to determine which treatment is most effective for the early correction of skeletal open bite. Future studies should include the assessment of long-term stability and analysis of cost and side effects of interventions.

6. Source of Funding

None.

7. Conflict of Interest

None.

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