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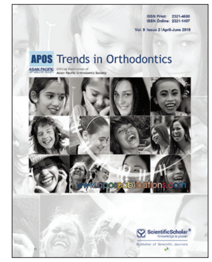

Review Article

Comparison of the treatment duration and effects of magnetic mandibular repositioning appliances and non-magnetic twin block in the treatment of growing patients with skeletal Class II malocclusion due to mandibular retrognathism – A systematic review

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ABSTRACT

Over the past two decades, magnets have been used in orthodontics and dentofacial orthopedics and various attempts have been made to evaluate the biological implications of magnets and magnetic fields. This systematic review aims to provide a detailed comparison between magnetic mandibular repositioning appliances and non-magnetic twin blocks on mandibular growth modification. The objective was to evaluate the treatment duration and effects of magnetic mandibular repositioning appliances and non-magnetic twin block in growing children with skeletal Class II malocclusion due to mandibular retrognathism. Literature search of electronic databases and additional manual search was done till June 2021. Randomized controlled clinical trials (CCTs), non-randomized CCTs, case reports, case series, and retrospective clinical trials in which magnetic appliances and non-magnetic twin blocks were used for the correction of skeletal Class II malocclusion are included in the present review. Correction of skeletal Class II malocclusion was achieved in a shorter treatment duration with magnetic mandibular repositioning appliances. Similar dental and skeletal effects were observed with both the appliances; however, maxillary restraining effect and reduced mandibular incisor proclination was evident with magnetic mandibular repositioning appliances. Magnetic appliance is proven to be more effective in correction of skeletal Class II malocclusion with mandibular retrognathism and maxillary prognathism with proclined lower incisors. This systematic review was registered on Prospero with registration number CRD42020165297.

Keywords: Functional magnetic appliance, Magnetic functional appliance, Growing patients, Twin block, Skeletal Class II malocclusion with retrognathic mandible

INTRODUCTION

Dentofacial deformities exist in the maxilla and/or mandible in all three dimensions of space, however, more frequently observed in the anteroposterior plane manifesting as either Class II or Class III malocclusions.

Class II malocclusion is undoubtedly the most frequent clinically encountered skeletal discrepancy, of which, mandibular skeletal deficiency is the single most common characteristic feature.[1]

In growing individuals, the primary treatment for Class II due to the retrognathic mandible is functional appliance therapy.[2] Functional appliance therapies have become an increasingly popular method to correct Class II malocclusion. The appliance developed more than 40 years ago by Clark and Clark is the most widely used since it has better patient tolerance acceptance, versatility, and minimal interference with speech.[3]

Vardimon *et al*. in 1989[4] and Darendeliler in 1993[5] introduced magnets in functional appliances for the correction of skeletal Class II malocclusion. They used Samarium cobalt magnets in either attractive or repelling mode to achieve orthodontic and orthopedic correction. Although these magnetic appliances had a favorable effect in the correction of skeletal Class II malocclusion, they did not gain popularity in contemporary orthodontics.

Knowledge gap

This systematic review was done in an attempt to evaluate that magnetic mandibular repositioning appliances corrects skeletal Class II malocclusion in a shorter duration with greater skeletal and less dental effects than non-magnetic twin block. Furthermore, there is no systematic review and literature available where a direct comparison between magnetic mandibular repositioning appliances and non-magnetic twin block is given. Hence, this review would prove to be useful for further research.

Focused question

Do magnetic mandibular repositioning appliances shorten the treatment duration when compared with non-magnetic twin blocks.

Primary objective

The primary objective of the study was to compare the treatment duration of magnetic mandibular repositioning appliances and non-magnetic twin block in the treatment of skeletal Class II malocclusion.

Secondary objective

The secondary objective of the study was to evaluate the treatment effects (skeletal and dental) of magnetic mandibular repositioning appliances when compared to non-magnetic twin blocks.

MATERIAL AND METHODS

Information sources

To identify the published studies or research, we searched the electronic databases from PubMed through MEDLINE, Google Scholar, and Cochrane central register of controlled trials. The database was searched from January 1970 to June 2021, since the rare earth magnets which are commonly used in functional appliances had their commercial start from the 1970s with no restriction on a date and without using any filter for magnetic mandibular repositioning studies, whereas randomized control trial filter was used for searching non-magnetic twin block studies without any limits which were applied for the English language and human subjects. All stages were conducted according to the current Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist. The international database of PROSPERO (prospectively registered systematic reviews in health and social care) and register of systematic reviews were searched in February 2020 showing no existing or current review protocols on comparison between magnetic mandibular repositioning appliances and twin block appliance.

Additional hand searching of reference lists of relevant articles, gray searching in Google Scholar, and correspondence with experts in the field were conducted for the location of any additional studies. Keywords and truncation symbols were utilized to retrieve all potential combinations of the search MeSH terms. Keywords and strategy and MeSH terms for PUBMED through Medline are shown in [Tables 1 and 2].

Eligibility criteria

1. Articles published till June 2021
2. Articles providing information of the growing participants undergoing functional orthopedic correction due to mandibular retrognathism
3. All articles in the English language
4. Studies with one-step mandibular jaw advancement
5. Full-text articles.

Exclusion criteria

1. Articles that were abstracts, letters to editorials, editorials, and animal studies

Table 1: Keywords.

Primary keywords	Secondary keywords
Magnetic mandibular repositioning appliance Growing children Twin block Skeletal Class II malocclusion with retrognathic mandible	Magnetic functional appliance Functional magnetic appliance Magnetic twin block

Table 2: Electronic search strategy for each database.

S. No.	Search strategy	No. of articles searched		No. of articles selected		Final selected articles	Reason for exclusion
		PubMed	Cochrane	PubMed	Cochrane		
SS1	Functional magnetic appliance and skeletal Class II malocclusion	24	3	3	1	3	Duplicates, failed to fulfill inclusion criteria
SS2	Magnetic activator device in Class II	39	7	1	0	1	Duplicates, failed to fulfill inclusion criteria
SS3	Magnetic forces in growth modification	28	0	0	0	0	Duplicates, failed to fulfill inclusion criteria
SS4	(Randomized clinical trial of twin block) OR (effects of twin block in the treatment of Class II malocclusion)	59	103	4	4	4	Failed to fulfill inclusion criteria

2. Articles that were unclear about the effect of magnetic mandibular repositioning appliances
3. Non-growing individuals
4. Syndromic cases.

PICO

- Participants – Growing children
- Intervention – Magnetic mandibular repositioning appliances.
- Comparative – Non-magnetic twin block appliance
- Outcome – Treatment effects.

Study selection

Screening of retrieved articles, assessment of the risk of bias, and extraction of data were conducted independently and any two discrepancies in results were resolved by discussion before combination. First, title and abstract screening were performed, followed by a full-text assessment for second-level evaluation. Any study where no abstract was available or the information available was inconclusive in reaching a decision was assessed in full text. During the screening, researchers were blinded to the author of the article, and journal to minimize potential biases in the selection process of primary studies. Where questions remained after full-text evaluation, efforts were made to contact relevant authors for clarification. The number of articles identified through electronic database search and manual hand search was 263. After a thorough reading of titles, 11 articles warranted relevance. Furthermore, duplicate articles were removed. Full texts of eight articles that were found potentially eligible were obtained and thoroughly assessed for eligibility. The distribution of the journals in which these articles were published is tabulated in [Table 3].

Table 3: Distribution of the journals in which the eight articles were published.

Name of journal	Number of studies
American Journal of Orthodontics and Dentofacial Orthopaedics	4
European Journal of Orthodontics	3
Seminars in Orthodontics	1

Quality assessment

The Newcastle–Ottawa scale was applied to assess the quality of the controlled CTs.[6] The studies were appraised and were designated "stars" based on three objectives:

1. Selection of study groups
2. Comparability of groups
3. Determination of outcome of the study.

The items and criteria of assessment were specified in [Tables 4 and 5].

Methodological assessment of the quality of the included studies/CTs (clinical trials) was assessed using the Newcastle-Ottawa scale. The scores ranged between 3 and 8, indicating that the quality of the studies was moderate to high.

The quality assessment of the RCT was done employing the checklist by the Cochrane Collaboration risk of bias tool.[7] The checklist provided by the Cochrane Collaboration risk of bias tool to assess the quality of RCTs was specified in [Tables 6 and 7]. Furthermore, the risk of bias was assessed using Rob tool 2[8] and not much difference was observed.

RESULTS

The total results of all electronic databases were 263 from which database PUBMED and Cochrane yielded a total of

263 results. Details of database results are shown in [Table 8]. Two hundred and fifty-five studies duplications were evident and failed to fulfill inclusion criteria so we excluded those studies from 263 and the last eight articles remained. Out of 263 results, 11 studies initially satisfied the inclusion criteria by reviewing abstracts but later on, three articles were excluded[9-11] due to various reasons which are mentioned in [Table 9]. Ultimately, eight articles were included in this review in which one case report, four RCTs, and three case series were considered. PRISMA flowchart is shown in [Figure 1]. Out of eight studies, four studies showed the effects of magnetic mandibular repositioning appliances, and the remaining four studies showed effects of non-magnetic twin block. These magnetic studies were carried out in Switzerland, Germany, Australia, and Turkey and non-magnetic twin block studies were carried out in the UK and Syria.

Table 4: Items and criteria for quality assessment with the Newcastle–Ottawa scale.

Selection	When the stars were designated
Representativeness of the exposed cohort	Truly representative of average somewhat representative of average
Selection of the non-exposed cohort	Drawn from the same community as the exposed cohort
Ascertainment of exposure	Secure record structured interview
Demonstration that outcome of interest was not present at start of	Yes
Comparability of cohorts on the basis of the design or analysis controlled for confounders	Study controls for the most important factor study controls for any additional factor
Assessment of outcome	Independent blind assessment record linkage
Was follow-up long enough for outcomes to occur	Yes (select an adequate follow-up period for the outcome of interest)
Adequacy of follow-up of cohorts	Complete follow-up subjects lost to follow-up unlikely to introduce bias; small number lost follow-up, or description provided of those lost

Study characteristics

The study characteristics are summarized in [Tables 10 and 11]. Two different types of appliances, that is, magnetic mandibular repositioning appliances and non-magnetic twin block were compared. Both skeletal and dental parameters were considered in this systematic review with treatment duration as a primary objective. The treatment modalities included magnetic mandibular repositioning appliances in four studies that employed MAD II, FOMA II, Sydney Magnoglide, and non-magnetic twin block in four studies to correct skeletal Class II malocclusion.

DISCUSSION

Following the aim of the present systematic review, the results of this systematic review showed that very limited data have been published on effects on magnetic appliances which include only case reports and case series (mainly retrospective and few prospective) with no randomized control trial and systematic review. Other primary searches also did not provide adequate conclusive data such as textbook references and other sources. Equivalently less randomized clinical trials were available in the non-

Table 5: This table shows the quality assessment of each study using the Newcastle–Ottawa scale. A maximum of one star could be assigned to each parameter under the selection and outcome categories, whereas two stars could be assigned in the comparability category.

Quality evaluation	Study			
	Darendeliler *et al.*, 1993	**Darendeliler, 2006**	**Yuksel *et al.*, 2010**	**Phelan *et al.*, 2012**
Representativeness of the exposed cohort				*
Selection of the non-exposed cohort		*		*
Ascertainment of exposure	*	*	*	*
Demonstration that outcome of interest was not present at start of	*	*	*	*
Comparability of cohorts on the basis of the design or analysis controlled for confounders				*
Assessment of outcome	*	*	*	*
Was follow-up long enough for outcomes to occur			*	*
Adequacy of follow-up of cohorts				*
	3	4	4	8

magnetic twin block group with the control group. No previous studies comparing these two appliances were found in the literature.

The low compliance from the patients with bulky conventional bite-jumping appliances has inspired considerable innovation and application of magnetic mechanisms to functional therapy. One advantage of the magnetic bite-jumping appliances lies in its "magnetic rest position" in which the mandible is held forward sufficiently and perpetually with a moderate bite opening. This permits a rapid adaptation of the masticatory muscles to mandibular protrusion and also encourages the patient to wear the appliance more persistently with little phonetic and masticatory compromise. It is widely accepted that continuous, rather than an intermittent, forward translation of the mandible is an important factor for the successful correction of Class II jaw discrepancy. For this reason, magnetic therapeutic mechanisms might be of interest and encourage further innovation and research. Future research should focus on a more consolidated force magnitude and decreased dimension of the magnets.

Treatment duration

Treatment time plays an important role during orthodontic treatment since many orthodontic patients are concerned about the amount of time that they will be required to wear functional appliances. In this systematic review, we have compared the treatment duration of magnetic appliances with non-magnetic twin blocks. The average treatment duration with a magnetic mandibular repositioning appliances was 4–5 months which was approximately half as that of a non-magnetic twin block appliance (10–12 months).

Table 6: Checklist provided by Cochrane Collaboration risk of bias tool to assess the quality of RCT.

Domains assessed for quality evaluation	Low	High	Unclear
Domains assessed for quality evaluation	+	–	?
Allocation concealment	+	–	?
Blinding of outcome assessment	+	–	?
Incomplete outcome data	+	–	?
Selective reporting (reporting bias	+	–	?
Other bias	+	–	?

Skeletal effects

Darendeliler and Joho[5] in their case report observed that the amount of skeletal versus dental response depends on the intensity of the magnetic force. If the force is too strong, it maintains the two appliances together and forms a traditional activator. Above 500 g, the muscle force necessary to unlock the magnets is transmitted through the appliances to the dental anchorage and seems to produce unwanted or exaggerated dental movements. Below 200 g, the magnetic force seems to be insufficient. Hence, a force of 300 g on each side seems to be appropriate. The study did not mention much about angular and linear changes. The ANB was reduced by 2°–3° when the MAD II appliance was used.

Darendeliler[12] in his study observed that MAD II produced combined skeletal and dental effects. There was a maxillary restraining effect (SNA reduced by 1.4°) and anteriorly repositioned mandible (SNB increased by 0.94°). The reduction of SNA by 1.4° is similar to Illing *et al.*'s twin block study[13] but greater than the result of the Trenouth[14] study, where the reduction in SNA was only 0.6°.

In Yüksel *et al.*[15] the study, SNA showed that the MAD II appliance inhibited maxillary growth by 0.9° which was insignificant in Yüksel *et al.*[15] study. SNA decreased non-significantly with MAD II application, which might be due to the observed increase in SN distance as a consequence of growth and development. ANB angle was significantly decreased during treatment ($P < 0.01$). The change in SNB angle was not statistically significant, however, a significant increase in mandibular length was observed with Barbre and

Table 7: This table shows the quality assessment of the RCTs using the Cochrane Collaboration risk of bias tool. A "+" sign indicates low risk of bias, whereas a "–" indicates high risk of bias. A "?" sign was assigned if the data provided was unclear.

	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting bias	Other bias
Burhan *et al.*, 2014	–	–	–	–	?	?	+
Dibiase *et al.*, 2019	–	–	+	+	?	?	+
Phelan *et al.*, 2012	+	+	?	?	+	_	+
Parekh *et al.*, 2019	–	–	–	+	?	?	+
Brian *et al.*, 2003	–	–	–	–	?	?	+
Darendeliler *et al.*, 1993	+	+	?	?	+	+	?
Darendeliler, 2006	+	+	?	?	+	+	+
Yuksel *et al.*, 2010	+	+	?	?	+	+	+

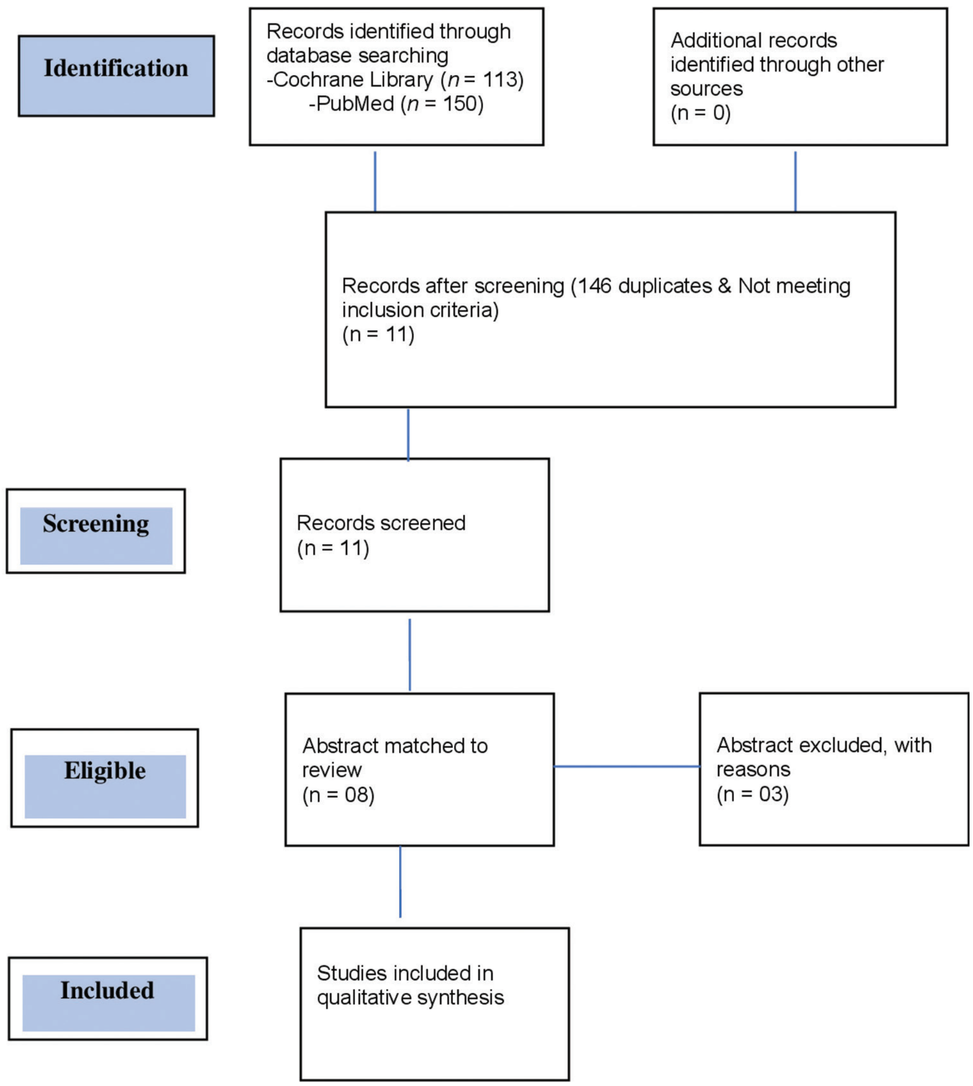

Figure 1: PRISMA flowchart.

Table 8: Search results by database.

Database	Results	Selected
PubMed	150	8
Cochrane	113	5
Other sources	0	0

Table 9: Excluded studies and reasons for exclusion.

S. No.	Studies	Reason
1.	Vardimon AD, Köklü S[9]	Only soft-tissue changes are considered
2.	Wu JY, Liu J [10]	Not in English Language
3.	Meral O, Yüksel S.[11]	Not meeting the inclusion criteria

Sinclair.[16] Mandibular effective length (Co–Gn) showed a significant increase by 4.8 mm ($P < 0.05$), which is in agreement with the previous studies (Kalra *et al.*, 1989).[17]

Phelan *et al.*[18] carried out a prospective clinical study that demonstrates that the Sydney Magnoglide is an effective appliance for functional Class II correction. The corrections of the overjet and molar relationship achieved in all patients treated with the Sydney Magnoglide were mainly associated with favorable skeletal mandibular changes. The outcomes of the orthopedic phase of treatment with the Sydney Magnoglide showed that 51.5% of the overjet correction was due to skeletal changes, almost exclusively in the mandible, the skeletal changes with the Sydney Magnoglide were due to skeletal modifications exclusively in the mandible. At the end of functional appliance therapy, the treated group showed an average gain of 5.2 mm in mandibular length; this is an average of 2.5 mm more than in the control group and

Table 10: Outcome of magnetic mandibular repositioning appliance studies.

	Author	Year	Country	Study design	Age	Sample	Duration	SNA angle	SNB angle	ANB angle	U1:SN angle	L1:Go Me angle	Overjet	Mandibular length	Molar relation
1	M. Ali Darendeliler *et al.*[5]	1993	Switzerland	Prospective	10 years 3 months 8 years 5 months 12 years 9 ½ months	3 case reports	5 months 11 ½ months 5 months	- - -	- - -	- Reduced by 2° Reduced by 3.5°	- - -	- - -	- Reduced by 7 mm -	- - Increased by 2.5 mm	Class I Class I Class I
2	Darendeliler[12]	2006	Australia	Experimental	Not mentioned	13 monkeys 10 samples (10 controls) 38 samples (19 controls)	4 months 4 months 4 months	- - Decreased by 1.4°	- - Increased by 0.94°	- - Decreased by 2.3°	- - Decreased by 3.6°	- - Increased by 2.21°	- - -	- Increased by 3.2 mm -	Class I Class I Class I
3	Yüksel *et al.*[15]	2010	Turkey	Experimental	10.5 years	10	9.5 months (active phase)	Decreased by 0.9°	Increased by 0.9°	Decreased by 1.7°	Decreased by 3.3°	Increased by 2.8°	Decreased by 3.6 mm	Increased by 4.8 mm	Class I
4	Phelan *et al.*[18]	2012	Germany	Prospective	Not mentioned	34 30	7–8 months	Decreased by 0.8°	Increased by 0.4°	Decreased by 1.2°	Decreased by 3.6°	Increased by 0.1°	Decreased by 3.4	Increased by 5.2 mm	Class I

Table 11: Outcome of non-magnetic mandibular repositioning appliance studies.

	Author	Year	Country	Study design	Age	Sample		Duration	SNA angle	SNB angle	ANB angle	U1:SN angle	L1:Go Me angle	Overjet	Mandibular length	Molar relation
1	Brian *et al.*[24]	2003	Manchester	RCT	11–14	110	105	11–14 months	Increased by 1.85°	Increased by 4.42°	Decreased by 2.57°	Decreased by 3.11	Increased by 0.56	Decreased by 6.24 mm	Increased By 3.46 mm	Class I
2	Burhan *et al.*[25]	2014	Syria	RCT	12.2–13 years	22	22	12 months	Decreased by 1.01°	Increased by 3.13°	Decreased by 3.95°	Decreased by 4.12°	Increased by 3.63°	Decreased by 4.75 mm	Increased by 2.42 mm	Class I
3	Parekh *et al.*[29]	2019	Switzerland	RCT	10–14 years	31	31	12 months	Increased by 0.5°	Increased by 1.54°	Decreased by 1.25°	Decreased by 1.59°	Increased by 4.19°	Decreased by 6.5 mm	-	Class I
4	DiBiase *et al.*[30]	2019	UK	RCT	11–14 years	78	78	15 months	Unchanged	Increased by 2.1°	Decreased by 2.2°	Decreased by 1.4°	Increased by 5.3°	Decreased by 7 mm	Increased by 6.2 mm	Class I

therefore almost twice the effect. The outcome for the Sydney Magnoglide was similar to that of the functional magnetic system,[9] which also had a 2-fold increase in mandibular length but was less favorable than the Herbst appliance, which enhances mandibular growth on average 3 times as much as the untreated control subjects.[19,20] There was a statistically significant increase in the SNB angle at the end of treatment. The Sydney Magnoglide had a negligible effect on the growth of the maxilla. There was on average 0.1 mm more forward maxillary growth in the treated subjects during the functional appliance phase of therapy compared with the controls. Investigations on twin block therapy also demonstrated no effect on the sagittal position of the maxilla.[21-23]

Twin block appliance increased the duration of treatment by a factor of 2.2 months compared with the Herbst appliance with shorter treatment times, compared with a factor of 1.5 months in with longer duration which was observed in O'Brien *et al.*[24] study. Pancher's analysis showed both the appliances twin block and Herbst produced almost similar effects with a greater increase in mandibular length with twin block.

Burhan *et al.*[25] in their RCT observed that both appliances (bite-jumping appliance and twin block) were effective in correction of skeletal Class II malocclusion. That conclusion appears obvious from the significant decrease in the ANB angle and the overjet during the treatment. The forward motion of mandible was demonstrated by a significant increase in the SNB angle by 2.88 degrees in the BJA group and 3.13 degrees in the TBA group. A significant increase in the dimensions of the mandible including the length of the mandible by 3.13 ± 1.20 mm ($P = 0.008$) and 2.42 ± 1.45 mm ($P < 0.001$) in the BJA group and TBA group and of the height of the mandible by 2.63 ± 1.28 mm ($P = 0.006$) and 2.52 ± 1.63 mm ($P < 0.001$) in the BJA group and the TBA group, respectively. Martina *et al.*[26] referred to a significant increase in the length of the mandible but an insignificant increase in the height of the mandible with the BJA. Conversely, Baysal and Uysal[27] reported a significant increase in the height of the mandible but an insignificant increase in the length of the mandible with TBA. No significant changes were observed in the maxilla in the sagittal plane. No significant changes were observed in the SNA angle in both study groups. This finding with some caution may indicate that the two appliances were able to restrict the growth of the maxilla. The upper incisors in this study were significantly proclined in the two groups. The root apices might have moved anteriorly and point A might have been advanced as a result of alveolar bone reshaping. The SNA angle did not increase under these circumstances, so it could be assumed that some restriction of maxillary growth had occurred. Studies of O'Brien *et al.*[24] and Tumer and Gultan displayed restriction of the maxilla,[28,24] whereas the study of Baysal and Uysal[27] did not. The differences in results between their study and the Burhan *et al.* study could be attributed to the differences in working methods.

Parekh *et al.*[29] the study was the first to demonstrate no significant differences in key dental and skeletal parameters between adolescent patients treated with a functional appliance prescribed for either part-time (PT) or full-time (FT) wear. No clinically or statistically significant differences between the PT and FT groups were noted concerning skeletal changes. However, a greater increase in mandibular length was observed with the FT wear group. SNB angle between groups increased approximately 1.5° over the 12 months. This mirrors previous research; by Baysal and Uysal.[27] Negligible changes in SNA angle were noted in both groups (0.03–0.5) with the FT group demonstrating slightly more maxillary restraint.

Dibiase *et al.*[30] in their RCT observed that the patients treated with the twin block appliance showed a greater reduction in the overjet and greater skeletal change for all parameters except the horizontal movement of A point. Fifteen months of therapy with the twin block was associated with a forward movement of the chin of 3.5 mm, similar to that reported in other studies.[23,24] The forward growth of the chin with the Dynamax was limited to 1.7 mm. There was some evidence of restraint in the maxillary growth in the Dynamax group with a forward movement of A point of only 0.2 mm over 15 months. The main skeletal change, however, is in the mandibular length, which increased by 6.2 mm in the twin block and 4.1 mm in the Dynamax. The twin block finding is similar to that of Lund and Sandler[23] with an increase in length by 5.1 mm and De Vincenzo of 6 mm.[31]

Dental effects

Extreme overjet of 13 mm reduced to 7 mm to achieve Class I relationship within 4 months in Darendeliler and Joho's[6] study.

Darendeliler[12] observed that with MAD II, the upper incisors were retroclined (1/SN reduced 3.6°), there was proclination of lower incisors (1/Md 2.2°), the change in upper incisor inclination (1/SN reduced 3.61°) is less than other studies using twin blocks (Illing *et al.*;[13] 1/PP reduced by 9.2°, Trenouth;[14] 1/PP reduced by 9.2°, and Trenouth; 1/PP reduced by14.27°). This difference may be due to the design of the appliances with the twin blocks incorporating a labial bow, whereas the MAD II utilized anterior torquing springs. The lower incisors proclined by 2.2° in the MAD II, which was not statistically significant when compared with the control group. This effect was similar to that produced by the twin block appliance where the lower incisors were proclined by 2.1°38 and 1.13°.3.

Yüksel *et al.*[15] found that the MAD II appliance produced a change in L1–NB angle was also significant ($P < 0.05$).

Overjet showed a significant decrease ($P < 0.001$), but the change in overbite was not significant. Overjet decreased significantly ($P < 0.001$) because of forwarding movement of the mandible and retroclination of the upper incisors.

Phelan *et al.*[18] in her study observed that the magnetic forces acting on the dentition are not continuous, leading to less dental movement with the Sydney Magnoglide. The average overjet and molar corrections at the end treatment were 3.5 and 4.7 mm, respectively. The molar correction with the Sydney Magnoglide compares favorably with studies of the twin block[22] and the functional magnetic system[9] demonstrating molar corrections of about 4.8 and 4.5 mm, respectively.

In Burhan *et al.*[25] RCT, the lower incisors were significantly proclined in the two groups. Lingual movement of lower incisor roots may allow alveolar remodeling, lingual movement of point B, and reduction of the SNB angle. Thus, an increase in the SNB angle in these circumstances demonstrates significant improvement. These results are in agreement with other studies on TBAs[32] and BJAs.[26] The lower incisors were significantly proclined by 3.25 ± 2.38° ($P = 0.007$) and 3.63 ± 1.62° ($P = 0.002$) in the BJA group and the TBA group, respectively. Lund and Sandler[23] and Mills and McCulloch[33] reported significant lower incisor proclination during functional treatment by 7.9° and 5.2°, respectively.[23,33] It can be noticed that although all of these studies mentioned significant lower incisor proclination, the lower incisor proclination in the current study is less than that in the above-mentioned studies because acrylic capping was done for lower incisors. The upper incisors were significantly retruded by −3.78 ± 1.07° ($P < 0.001$) and −4.12 ± 1.83° ($P = 0.005$) in the BJA group and TBA group, respectively. The retrusion of the upper incisors is a consistent finding in many previous studies.[26,27,34] This finding can be interpreted as a posterior reaction resulting from the anterior advancement of the mandible. The labial bow of maxillary plates in both study groups was not activated to avoid the upper incisor retrusion and consequently to avoid a dental constraint on mandibular growth stimulation.[26]

In a study by Parekh *et al.*,[29] overjet reductions between 6.5 and 7 mm were observed in both groups. These levels were significant and confirmed the potency of the appliance with both treatment regimens but also reflected the magnitude of the baseline overjet (10.3–11.1 mm). This much overjet reduction compares favorably with a previous meta-analysis (5.2 mm)[13] and mirrors findings by O'Brien *et al.*,[24] who noted a reduction of 6.2 mm in patients treated with a twin block appliance for a mean period of 11 months.

Dibiase *et al.*[30] in his study observed that a mean overjet reduction occurred of 7 mm (±2.3) with the twin block and 5.8 mm (±2.1) with the Dynamax [Tables 1-3]. This was associated with retroclination of the upper incisors by −5.8° (±10.0) in the twin block group and −5.7° (±11.2) in the Dynamax group ($P = 0.97$). The lower incisors were proclined by 5.3° (±4.8) in the twin block group and by 5.4° (±6.0) in the Dynamax group ($P = 0.96$) Over a 15-month treatment period, the maxilla had a mean forward movement at A point of 0.8 mm (±1.7) with the twin block and 0.2 mm (±1.5) with the Dynamax ($P = 0.06$) [Tables 1-3]. Statistically, significant differences were found in the forward movement of the chin at pogonion of 3.5 mm (±2.5) with the twin block and 1.7 mm (±2.1) with the Dynamax ($P < 0.01$). There was an increase in the mandibular length by 6.2 mm (±2.5) with the twin block and 4.1 mm (±2.6) with the Dynamax ($P = 0.007$).

CONCLUSION

1. Treatment duration of magnetic appliances was less as compared to non-magnetic twin block
2. Both magnetic and non-magnetic appliances produced similar dental and skeletal effects in the correction of skeletal Class II malocclusion
3. The maxillary restraining effect was observed with magnetic appliances. Furthermore, mandibular incisor proclination was less with magnetic mandibular repositioning appliances compared to non-magnetic twin block
4. Therefore, a magnetic appliance can be a better choice of the appliance in the correction of skeletal Class II malocclusion with mandibular retrognathism and maxillary prognathism with proclined lower incisors.

Further high-quality studies, such as RCTs, are needed to elucidate the effects of magnetic appliances and non-magnetic twin block in the long term and the possible different responses to treatment timing variability.

Limitations

There are relatively a small number of studies included in this systematic review. The methodological flaws in the magnetic appliance studies group reflected a high risk of bias because of non-randomized control trials. Long-term follow-up in both groups was not considered. Another limitation is the lack of a control group in magnetic appliance groups. The reason for not conducting meta-analysis was as follows:

1. If studies are clinically diverse, then a meta-analysis may be meaningless and genuine differences in effects may be obscured. A particularly important type of diversity is in the comparisons being made by the primary studies. Often, it is not very meaningful to combine all included studies in a single meta-analysis, sometimes, there is a mix of comparisons of different treatments with different comparators, each combination of which may need to be considered separately. Further, it is not important to combine outcomes that are too diverse

2. Meta-analyses of studies that are at risk of bias may be seriously misleading. If bias is present in each (or some) of the individual studies, meta-analysis will simply compound the errors and produce a "wrong" result that may be interpreted as having more credibility.

Declaration of patient consent

Patient consent is not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

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