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THE MAGNETIC HABIT REMINDER FOR THE CORRECTION OF THUMB SUCKING HABIT. A PROSPECTIVE CLINICAL TRIAL.

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Abstract

Objective: *the aim of this study was to evaluate the efficiency of a new magnetic habit reminder in cessation of thumb sucking habit and correction of Anterior open bite.*

Material and Methods: *This was a prospective clinical trial. The sample consisted of 20 subjects (7 boys and 13 girls) between the age of 5-12 years. Patients were eligible for this study if they had a thumb sucking habit with anterior open bite. Whereas the exclusion criteria included subjects with a history of previous orthodontic treatment, systemic diseases, and/or presence of any clefts. The appliance is a custom made fixed, removable appliance. It consists of two parts (intraoral and extraoral parts) enclosing two poles of gold coated neodymium and iron boron magnets. After insertion of the appliances, the participants were recalled every 4 weeks. At the end of the 6th month of this study, the appliances were removed, and post-treatment records were taken.*

Results: *PP/MP, FH/MP and LAFH/AFH showed significant reduction after treatment while PFH/AFH posttreatment significantly increased than pretreatment measurement. U1/PP, U1/SN, U1/NA(°) and U1/NA(mm) posttreatment measurements were significantly lower than pretreatment measurements. L1/MP, L1/NB (°), L1/NB(mm), UI/LI had no significant change after treatment. Nasolabial angle showed no significant change and the interlabial gap significantly reduced after treatment. Overjet was significantly reduced and overbite was significantly increased.*

Conclusion: *The magnetic habit reminder was capable of stopping thumb sucking habit within the 6-month duration of the study with improvement of malocclusion associated with the habit.*

Introduction

Thumb sucking is the most common oral habit in young children with a prevalence between 13% to 100% [1]. Its chronic practice after age of four can lead to dental and skeletal malocclusion that requires orthodontic intervention [2].

Orthodontic treatment of thumb sucking with anterior open bite (AOB) should be done early in the mixed dentition as it increases the possibilities of success and stability with improved mastication, esthetics and speech [3, 4]. Moreover, it can restrict or redirect vertical facial growth of the patient [3, 4].

Treatment of thumb sucking habit can be done with removable or fixed habit breaking appliances such as palatal crib, palatal spurs and blue grass appliances. Their mode of

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action depends on impeding the mechanical factors (thumb pressure) that maintains the anterior open bite [5]. Nonetheless, some patients reported some speech difficulties and unaesthetic appearance with the previously mentioned habit breaking appliances [5]. Also, many of these appliance need a lengthy duration of treatment in order to prevent thumb sucking habit with some reports of relapse of both anterior open bite and thumb sucking habit [6,7]. Therefore, the need for a new appliance with better esthetics and patient acceptance became a necessity. Thus, the aim of our study was to evaluate the efficiency of a new magnetic habit reminder in cessation of thumb sucking habit and correction of Anterior open bite.

Material and methods

Study design

This study was a prospective clinical trial. The study design was approved by the ethical committee of Faculty of Dentistry, Ain Shams University. No change to the study design took place after commencement of the study.

Sample size calculation

The sample size was calculated based on a study by Leite et al [8]. Sample size was calculated using G* power software version 3.1.3 (University of Dusseldorf, Dusseldorf, Germany) for the primary outcome. When the power was set at 80% and a significance level of 0.05, the power analysis yielded a total sample size of seventeen individual. We selected twenty participants to compensate for any possible dropouts.

Participants, Eligibility Criteria, and Settings

Recruitment of the participants was carried out from the outpatient clinic, Orthodontic Department, Faculty of Dentistry, Ain Shams University. An information explanation sheet about the study was given to the patient and their guardians after which an informed consent was obtained.

The sample consisted of 20 subjects (7 boys and 13 girls) between the age of 5-12 years. Patients were eligible for this study if they had a thumb sucking habit with anterior open bite. Whereas the exclusion criteria included subjects with a history of previous orthodontic treatment, systemic diseases, and/or presence of any clefts.

For all participants, extra and intra-oral photographs, study models, panoramic and cephalometric radiographs were obtained before and after treatment.

Design of the Appliance

It is a custom made fixed-removable appliance. It consists of two parts (intraoral and extraoral parts) enclosing two poles of gold coated neodymium and iron boron magnets:

I) Intra-oral fixed acrylic part (fig.1).:

a) acrylic part covering the anterior portion of the palate with disk shaped magnet of 12mm diameter x 2mm thickness embedded into it.

b) two stainless steel orthodontic first molar bands attached to the acrylic part via 0.9mm thick stainless-steel wire soldered to them.

Figure (1): intraoral acrylic part

II)Extra-oral removable thumb cover (fig.2):

It is a transparent cover with a disk-shaped magnet of 4mm diameter x 1.5mm thickness embedded into it at the position of the palm of the thumb. It covers the thumb except the nail area and the joints of the thumb that are left uncovered to allow free movement of the thumb. It is designed with holes all over the cover to keep the thumb ventilated.

Figure (2): Transparent thumb cover

Fabrication of the appliance

Separators were placed 48 hours to open the contacts and facilitate seating the bands. Bands were selected to be snuggly fitted on upper first permanent molars or second deciduous molars. Then impression was taken for the upper arch and the child thumb by alginate material, the bands were removed from the patient's mouth, then repositioned and secured in the impression before pouring.

The impressions were poured, and the design of both parts (intraoral and extraoral parts) was drawn on the models (fig.3).

Figure (3): Design of intraoral and extraoral part

The intraoral acrylic part was constructed from cold cured acrylic resin enclosing the magnet and 0.9mm stainless steel wire soldered to the bands. It is finished and polished and kept in water for 24 hours before cementation intraorally.

The extraoral thumb cover was fabricated using vacuum forming machine where the thumb model with the magnet glued to it with resin composite on its predetermined location and fixed on the machine table.

The thumb model was removed, and the cover was dislodged from the model and trimmed to the drawn design (fig.4).

Figure (4): final design of the cover

Appliance mode of action

The appliance has a dual action both mechanical and physical. The mechanical barrier of this appliance is the intraoral part which act as a mechanical obstacle between the thumb and the palate to break the pleasure of sucking. The physical barrier is the presence of repulsive force between the magnets embedded in the intraoral acrylic part and the extraoral thumb cover. That additional force prevents the child's thumb from reaching the palate.

Follow up visits

After insertion of the appliances, the participants were recalled every 4 weeks for check-ups. At the end of the 6th month of this study, the appliances were removed, and post-treatment records were taken. The casts were digitally scanned using desktop scanner (Trios 3Shape, Copenhagen, Denmark). Then analyzed using 3shape Ortho Analyzer while

the lateral cephalograms were digitally traced and analyzed using OrisCeph® Rx3 software.

Statistical analysis:

Data were collected, organized, tabulated and statistically analyzed using SPSS 20®, Graph Pad Prism® and Microsoft Excel 365. Shapiro Wilk and Kolmogorov tests were used for normality exploration. Paired t- tests were used to compare before and after treatment for the subjects. The results were assessed at a level of significance 5%.

Method Error

Intra-operator and inter-operator error of measurement were done to assess the reliability of measurements. five subjects were randomly selected for assessment of the reliability of measurements. For intra-operator error, the measurements were repeated by the same operator after at least two weeks of the first measurement. For inter-operator error, another trained orthodontic operator analyzed the measurements on the same five subjects.

RESULTS

All data showed normal parametric distribution. Results for the effect of appliance insertion on lateral cephalometric measurements are presented in table (1-3) and in figures from (5-8). Skeletal measurements: PP/MP, FH/MP and LAFH/AFH showed significant reduction after treatment while PFH/AFH posttreatment significantly increased than pretreatment measurement ($p<0.05$). Dental measurements: U1/PP, U1/SN, U1/NA(°) and U1/NA(mm) posttreatment measurements were significantly lower than pretreatment measurements ($p<0.05$). while L1/MP, L1/NB (°), L1/NB(mm), UI/LI had no significant change after treatment ($p> 0.05$). Soft tissue measurements: nasolabial angle showed no significant change, in the other side, the interlabial gap significantly reduced after treatment.

Table (1): Minimum, maximum, mean and standard deviation of pre and post treatment skeletal measurements, and difference between them using Paired t-test

Skeletal analysis		Min	Max	M	SD	Difference (Paired t-test)					
						MD	SD	SEM	95% CI		P value
									Lower	Upper	
SN/MP	Pre	30.00	42.00	36.25	2.34	-1.08	2.49	0.56	-0.09	2.24	0.07
	Post	33.00	45.00	35.18	2.76						
PP/MP	Pre	28.00	40.00	35.25	2.07	-2.75	1.94	0.43	1.84	3.66	<0.05*
	Post	30.00	41.00	32.50	2.46						
FH/MP	Pre	27.00	37.00	31.65	1.87	-1.88	1.82	0.41	1.02	2.73	<0.05*
	Post	28.00	33.00	29.78	1.22						
PFH/AFH	Pre	54.00	62.00	59.08	2.20	2.94	1.88	0.42	-3.81	-2.06	<0.05*
	Post	59.00	63.00	62.01	1.03						
LAFH/AFH	Pre	52.80	62.00	59.55	2.17	-1.98	1.54	0.34	1.26	2.70	<0.05*
	Post	54.20	59.20	57.57	1.07						

*significant ($p<0.05$)

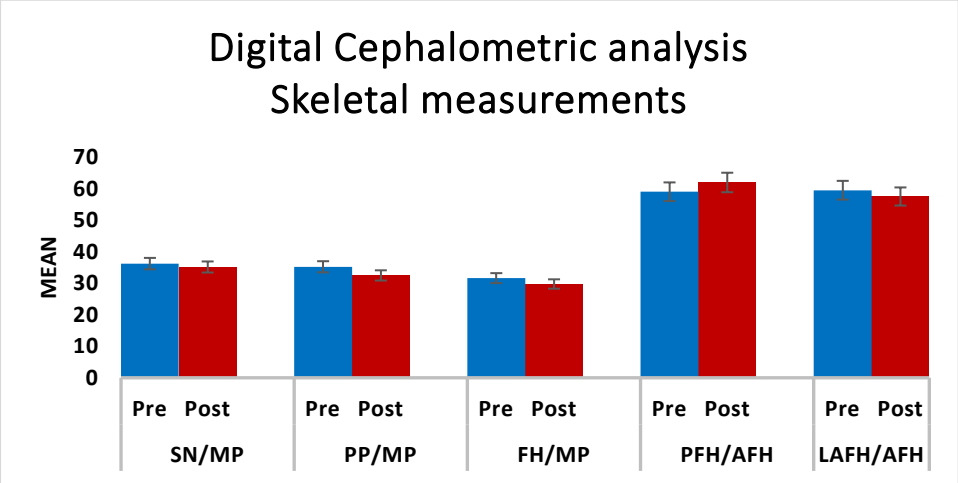

Figure (5): Bar chart showing pre and post treatment skeletal measurements

Table (2): Minimum, maximum, mean and standard deviation of pre and post treatment dental measurements and difference between them using Paired t-test

Dental measurements		Min	Max	M	SD	Difference (Paired t-test)					
						MD	SD	SEM	95% CI		P value
									Lower	Upper	
U1/PP	Pre	105.00	125.00	115.90	5.76	-4.80	4.10	0.92	2.88	6.72	0.00*
	Post	103.00	120.00	111.10	4.35						
U1/SN	Pre	92.70	124.00	110.67	7.09	-5.05	5.09	1.14	2.66	7.43	<0.05*
	Post	98.40	113.00	105.62	4.21						
U1/NA(°)	Pre	15.00	35.00	27.36	5.41	-2.73	4.28	0.96	0.73	4.73	0.01*
	Post	12.90	29.00	24.63	4.01						
U1/NA(mm)	Pre	4.00	8.00	6.01	1.06	-0.67	1.41	0.32	0.01	1.33	0.05*
	Post	4.00	7.00	5.34	0.86						
L1/MP	Pre	83.50	108.00	95.23	6.20	2.26	5.08	1.14	-4.63	0.12	0.06
	Post	87.00	110.30	97.49	5.48						
L1/NB(°)	Pre	15.00	48.00	28.09	6.70	2.30	4.82	1.08	-4.55	-0.04	0.05*
	Post	20.00	43.50	30.39	5.65						
L1/NB(mm)	Pre	4.00	10.40	5.53	1.61	0.39	1.69	0.38	-1.18	0.40	0.32
	Post	4.00	9.40	5.92	1.22						
U1/L1	Pre	97.00	135.00	119.92	9.84	1.53	5.28	1.18	-4.00	0.95	0.21
	Post	100.00	135.00	121.45	9.25						

*significant ($p<0.05$)

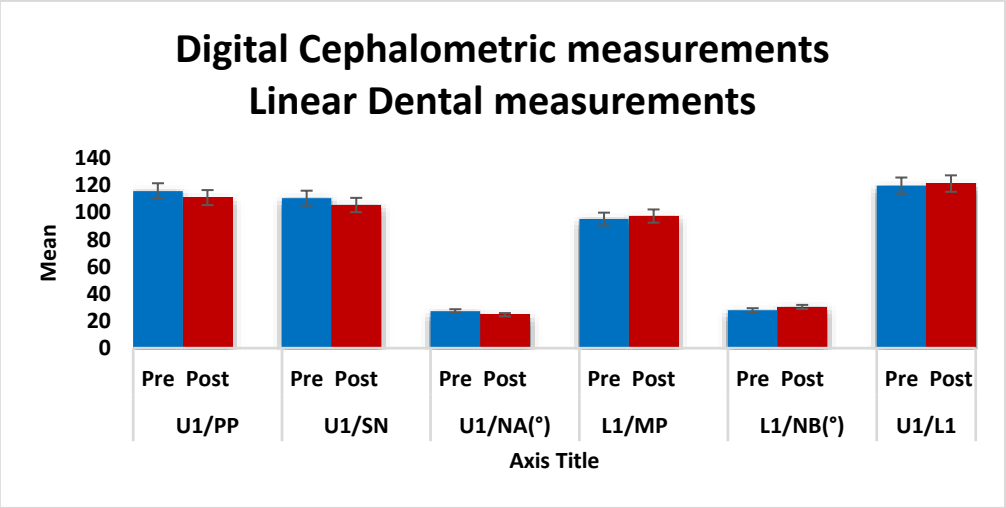

Figure (6): bar chart showing pre and post treatment linear dental measurements.

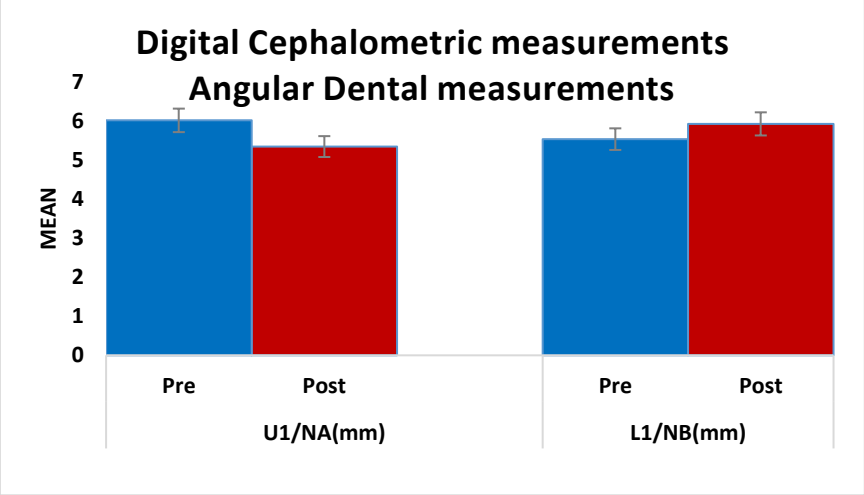

Figure (7): bar chart showing pre and post treatment angular dental measurements.

Table (3): Minimum, maximum, mean and standard deviation of pre and post treatment soft tissue measurements, and difference between them using Paired t-test

Soft tissue		Min	Max	M	SD	Difference (Paired t-test)					
						MD	SD	SEM	95% CI		P value
									Lower	Upper	
Nasolabial angle	Pre	75.00	126.00	97.81	13.52	1.06	8.77	1.96	-3.04	5.17	0.59
	Post	76.20	122.00	96.75	13.92						
Interlabial gap	Pre	2.00	10.00	5.35	1.81	2.95	1.32	0.29	2.33	3.57	<0.05*
	Post	0.00	4.00	2.40	1.05						

*significant ($p<0.05$)

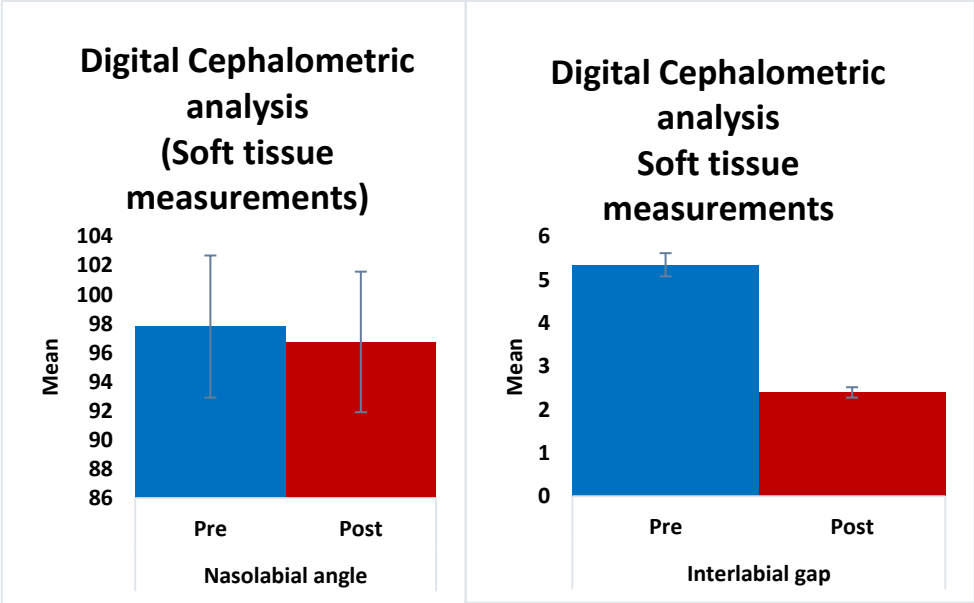

Figure (8): bar chart showing mean of pre and post measurements of nasolabial angle and interlabial gap

Results for the effect of appliance insertion on digital cast measurements are presented in table (4) and in figure (9). Overjet posttreatment was significantly lower than pretreatment measurements ($p<0.05$). Overbite was significantly higher than pretreatment measurements ($p<0.05$).

Table (4): Minimum, maximum, mean and standard deviation of pre and post treatment cast measurements and difference between them using Paired t-test

Digital cast analysis		Min	Max	M	SD	Difference (Paired t-test)					
						MD	SD	SEM	95% CI		P value
									L	U	
Overbite	pre	-6.59	-0.5	-2.95	1.67	3.41 -115.95%	1.31	0.29	2.47	3.69	<0.05*
	post	-2.43	2.56	0.46	1.33						
Overjet	pre	2.09	10.60	5.60	2.18	-1.37	0.77	0.17	-1.73	-1.01	<0.05*
	post	1.20	7.36	4.23	1.56						
	post	3.00	21.00	10.46	5.65						

*significant ($p<0.05$)

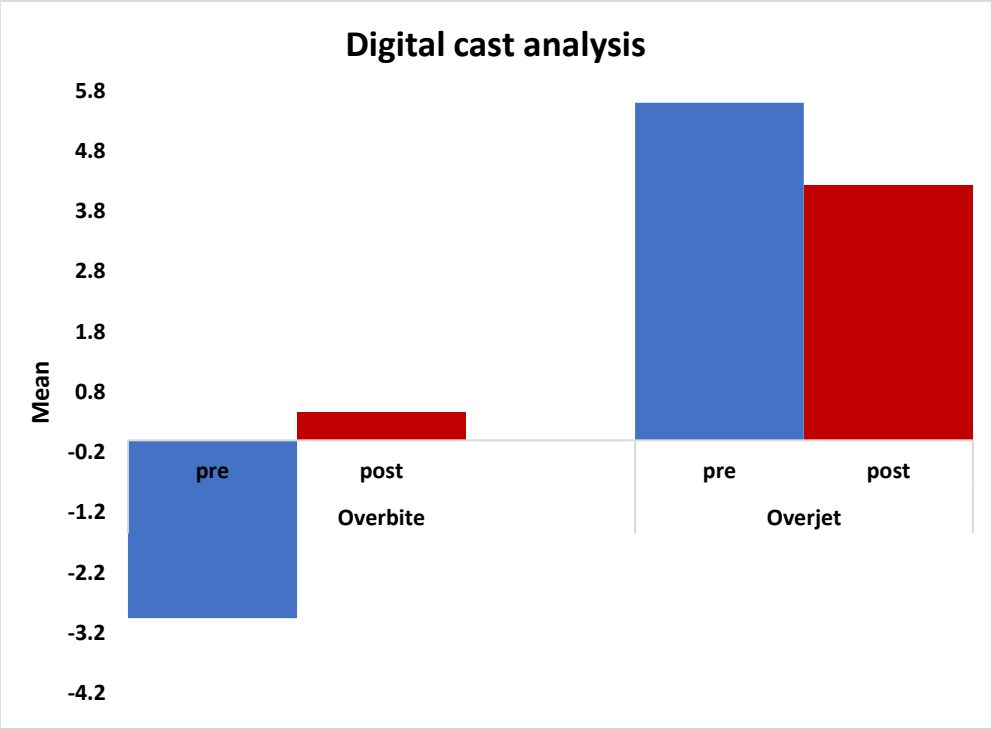

Figure (9): bar chart showing pre and post treatment cast measurements (Overjet and overbite)

DISCUSSION

Thumb sucking chronic practice after age of four can lead to unfavorable effects on the dento-facial complex, associated with bad psychological impact that necessitate orthodontic intervention [2]. Appliances for thumb sucking cessation have many drawbacks such as tongue irritation, difficulty to maintain good oral hygiene, difficulty of speech and eating, negative emotional reactions and self-inflected trauma [9,10].

The choice to incorporate magnetic components in our appliance is based on the assumption that the use of both mechanical and physical barriers can help stop thumb sucking habit in a shorter period of time with greater stability. This contrasts with the other habit breaking appliances which include only a mechanical barrier such as palatal crib or palatal spurs.

In this study, our sample consisted of twenty participants (7 boys,13 girls). This sample size was larger than that of Meyer et al [11], McRae [12] and Suwwan [13] who conducted clinical studies on habit breaking appliances with sample size of 15 ,12 and 8 subjects respectively. The age range of our participants was (5-12 years) with mean of (9.2 ±1.3 years) and the choice of this age group was based on a recommendation of cassis et al [14] who suggested that the correction of AOB with respect to oral habit cessation is better to be in the mixed and early permanent dentition phase to produce rapid favorable skeletal changes and maximize long term stability. This age range was comparable to those of Suwwan [13] and Baker[15].

The duration of time needed to stop thumb sucking habit is still controversial [7, 12, 16, 17]. some authors such as Rossato et al [17]

suggested a 1-year period as the minimal duration needed to produce the desired habit cessation effect while Cozza et al [16] required a longer duration (2 years) to get the maximum stability for both dento-alveolar and skeletal vertical modifications. Similar to our study, Haskell and Mink [7] and McRae [12] recommended a 6 months period as a sufficient time for habit correction and a subsequent increase in overbite.

The results of digital cast measurements showed that there was statistically significant improvement of the overbite after treatment with the magnetic habit reminder with AOB reduction of 3.19mm. This change was larger than that reported by Rossato et al [17] who showed a reduction by 3.1 mm over 1 year and McRae [12] and Leite et al [8] with mean AOB reduction 1.71mm and 2.14mm respectively in 6 month period. Also, Meyer et al [18] reported a reduction in AOB by 1.95mm in 9 months. This data suggests that the magnetic habit breaking appliance is superior to other habit breaking appliances in AOB reduction. This could be attributed to the dual action (mechanical and physical barrier) of the magnetic habit breaking appliance. Moreover, subjects experienced a significant overjet reduction (mean 1.37 mm). This usually occur due to the correction of proclination of upper incisors after habit cessation. This overjet reduction is higher than that reported when using palatal spurs as a habit breaking appliance [8] (mean overjet reduction of 0.57mm in 1one year) and comparable to a reported result of usage of a combined palatal crib and quadhelix appliance for habit breaking [16] (mean overjet reduction of 1.7mm in two years).

The results of lateral cephalometric measurements showed that there was significant reduction in PP/MP by 2.75° after treatment with magnetic habit reminder, this readings was greater than that reported by Erverdi et al [19] after treatment of thumb sucking with crib appliance for one year (mean change of 0.44°). This means more counterclockwise rotation of the mandible had occurred with the magnetic appliance. This counterclockwise mandibular rotation was consistent with the work reported by Johnson and Larsson [26] indicating that the growth pattern of the mandible changes concurrent with cessation of thumb sucking habit.

Also, LAFH /AFH ratio was significantly decreased by 1.98% indicating clockwise rotation of the anterior maxilla; this favorable change may have occurred because the thumb pressure is no longer affecting the palatal areas when magnetic habit reminder. Based on what was reported by Brenchley [21]; this clockwise rotation of the maxillary plane occurs during treatment of thumb sucking, with the anterior segment moving in a downward direction and the posterior segment moving in an upward direction.

Moreover, the proclination of the maxillary incisors showed statistically significant reduction after treatment. This result was more than what was reported by Suwwan [13] and Rossato et al [17] after treatment with palatal spurs and bluegrass. That greater correction of maxillary incisors proclination may have occurred because of the magnetic repulsion

force of the habit reminder stopping the thumb effect on upper incisors. On the other hand, mandibular incisors had no statistically significant change after treatment. This was similar to what was reported by Leite et al [8] where the mandibular incisors' inclination had no or slight change after treatment. Sorokohit and Nanda [22] reported that the type of malocclusion is determined by thumb position during sucking. Also, Substelny [23] mentioned that 50% of thumb suckers gently touch lower incisors and about 18% do not touch the lower incisors during thumb sucking

The results showed that the nasolabial angle had no statistical significance after treatment similar to the results of Cozza et al[16]. However, the interlabial gap showed statistically significant reduction after treatment by 2.95 mm similar to those findings reported by Ghobashy and Ghoname [24].

The results of this trial show that the incorporation of magnets in this habit reminder was found to have dual action -a combination of mechanical and physical barriers- to break the thumb sucking habit and provide correction of malocclusion caused by the thumb sucking habit. Moreover, the association of a small intraoral component also enhances the acceptance by children.

Conclusion

1. The magnetic habit reminder was capable of stopping thumb sucking habit within the 6-month duration of the study.

2. The anterior open bite and increased overject associated with the habit was significantly corrected using the appliance.

3. There was a clockwise rotation of the maxilla with decreased interlabial gap in subjects treated with magnetic habit reminder.

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