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Evaluating The Effect of Sabbagh Universal Spring^2 During Treatment of Growing Class II Malocclusions

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Abstract: *Angle Class II division 1 malocclusion has been one of the most encountered problems in the orthodontic practice. In growing patients, mandibular repositioning appliances are the method of choice to induce mandibular growth and are termed functional appliances. This study was carried out to investigate the possible effect of the Sabbagh Universal Spring^2 (SUS^2) on the dental and skeletal cephalometric measurements in the permanent dentition of ten growing patients with Class II division 1 malocclusion and to compare its effect with the similar available data of similar fixed functional appliances. It was concluded that the Sabbagh Universal Spring^2 appliance works well with the treatment philosophy of Class II division 1 malocclusion with retruded mandible by advancing the mandible anteriorly.*

INTRODUCTION:

Angle Class II malocclusion is one of the most common malocclusions. It represents about 21% of the Egyptian adult population and about 15-20% in Caucasian population. Class II division 1 is more common than division 2. About two thirds of typical Class II malocclusions are mostly due to mandibular retrusion. The attempted growth modification or extraction camouflage treatments can in many cases provide well-detailed occlusions, ideal smile width and pleasing, relaxed lip curves.[1-3]

Orthodontists have used functional appliances for more than 100 years mainly in the treatment of Class II/1 malocclusions in growing individuals. Fixed functional appliances are normally known as "non-compliance Class II correctors" when we compare them to removable appliances. However, for treatment to be successful, good cooperation is always necessary, especially if skeletal modifications instead of dentoalveolar compensation are desired.[4]

Fixed functional appliances became increasingly popular because of patient acceptance, minimal interference with speech, invisibility and ease of delivery and activation.[1] Examples of these are: Herbst Appliance®*, Jasper Jumper™**, Forsus spring™*** and Sabbagh Universal Spring®****. A fixed functional appliance can save both time and trouble. This treatment effectively shortens the duration of therapy and ideal use can be made of the remaining growth of a patient beyond the pubertal growth spurt.[5-7]

The first fixed functional appliance, still in use today, was developed as long ago as 1905 by a German professor, Emil Herbst (1842-1917) at the Berlin Dental Congress in 1905. He presented a series of articles in the *Zahnarztliche Rundschau* on his experiences with the appliance.[8-9]

Fig (1) Original design from Herbst's 1910 text.

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After 1934, however, very little was published on the subject, and the treatment method was more or less forgotten. In 1979 Hans Pancherz called attention to the possibilities of stimulating mandibular growth by means of the Herbst appliance. Recently, the Herbst treatment method has gained increasing interest, especially in the United States and several articles on appliance design have been published. The appliance has several advantages when compared to removable bite-jumping appliances (functional appliances): (1) the Herbst appliance works 24 hours a day, (2) no cooperation from the patient is required, and (3) treatment time is short (approximately 6 to 8 months). The original technique is not particularly comfortable for the patient since the appliance is stiff and non-flexible. In addition, fitting it is complicated.[10-12]

James J. Jasper in 1987 developed and patented the so-called Jasper Jumper. The Jasper Jumper exerts a light, continuous force and can deliver functional bite jumping with headgear-like forces, activator-like forces, elastic-like forces or a combination of these.[6,13-14]

According to Dionne, the Forsus Fatigue-Resistant Device is a hybrid appliance designed to address the problem of fatigue failure and consists of a three-piece telescopic spring device. The Forsus Fatigue Resistant Device (FRD) can be used instead of Class II elastics in mild cases and instead of Herbst appliances in severe cases.[15-16]

SABBAGH UNIVERSAL SPRING (SUS):

Sabbagh Universal Spring® (SUS) was invented and Developed by Dr. Aladin Sabbagh in 1997 (Fig-2) with a registered patent. Recently a modification of the spring, Sabbagh Universal Spring$^{2®}$ (SUS^2) - (Fig-3) has been developed with more benefits to optimize its results.[17]

The Sabbagh Universal Spring (SUS) is a telescopic device similar to the Herbst externally but with a different mode of activation. The SUS consists of a telescopic rod fitted into a guide tube. Inside the guide tube is a spring that can be adjusted to deliver different force levels, depending on the severity of the Class II malocclusion (Fig. 4 A and B). Its U-

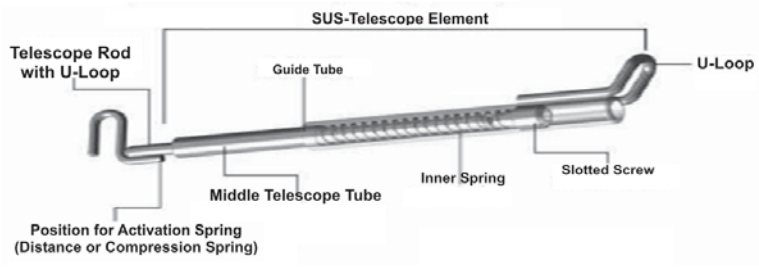

Fig (2) The Sabbagh Universal Spring (SUS), the original version.

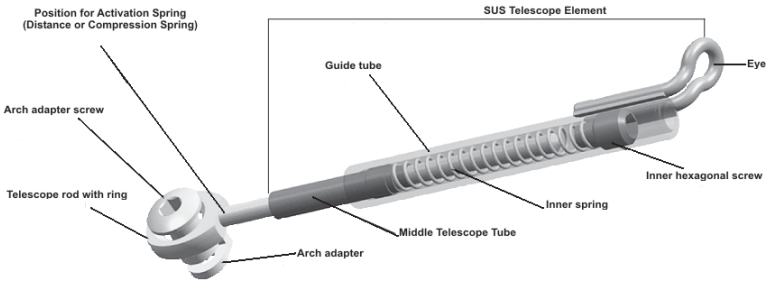

Fig (3) The Sabbagh Universal Spring$^{2®}$(SUS^2).

Table I : The means, standard deviations (SD), and the results of paired t-test of the Cephalometric Angular Measurements before and after Appliance treatment period:

Measurements	Pretreatment		Posttreatment		Changes		Significance	
	Mean	SD	Mean	SD	Mean	SD	*t-value*	*P-value*
SNA°	81	2.30	80.6	2.62	0.4	0.45	2.75	0.02*
SNB°	74.1	1.96	74.95	1.64	.85	.66	-4.02	0.003**
ANB°	6.9	1.52	5.65	1.73	1.25	0.63	6.22	0.000**
SN^MeGo°	38.5	4.69	39.3	5.43	0.8	1.31	-1.92	0.09
SN^OcP°	21.65	3.44	23.3	3.19	1.65	1.39	-3.73	0.01**
Y-axis°	71.4	3.43	72.2	3.22	0.8	1.20	-2.09	0.07
L/T FHt %	0.59	0.02	0.594	0.02	0.004	0.006	-1.80	0.10
U1^SN°	103.45	4.8	98.1	4.40	5.35	2.3	7.14	0.000**
L1^MeGo°	95.8	7.84	100.8	4.63	5	3.46	-4.56	0.001**

SD = Standard Deviation
Not significant if $P > 0.05$
(*) = Significant if $P \leq 0.05$
(**) = Highly Significant if $P \leq 0.01$

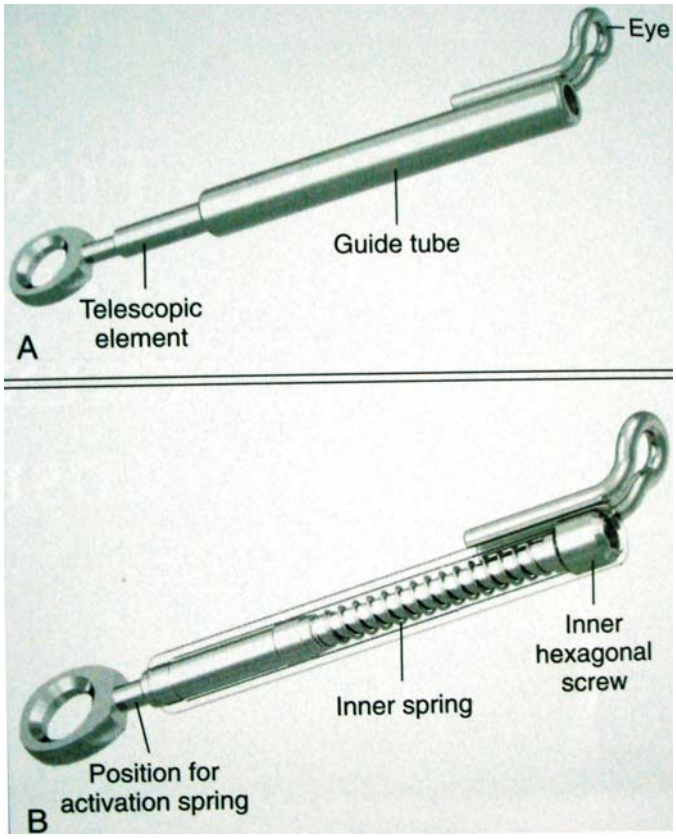

Fig (4) The Sabbagh Universal Spring[2] (SUS[2]).
A. Telescopic rod is fitted into the guide tube.
B. Spring inside the guide tube can be adjusted to deliver different force levels.

loop is designed to fit into the maxillary first molars while the lower end is attached to the archwire between the first premolar and the canine or even between the canine and the lateral incisor. Unlike the Forsus, the SUS is a true universal spring in that it does not have a left or right side. It is considered the latest interarch compressive spring to be introduced. A second coil

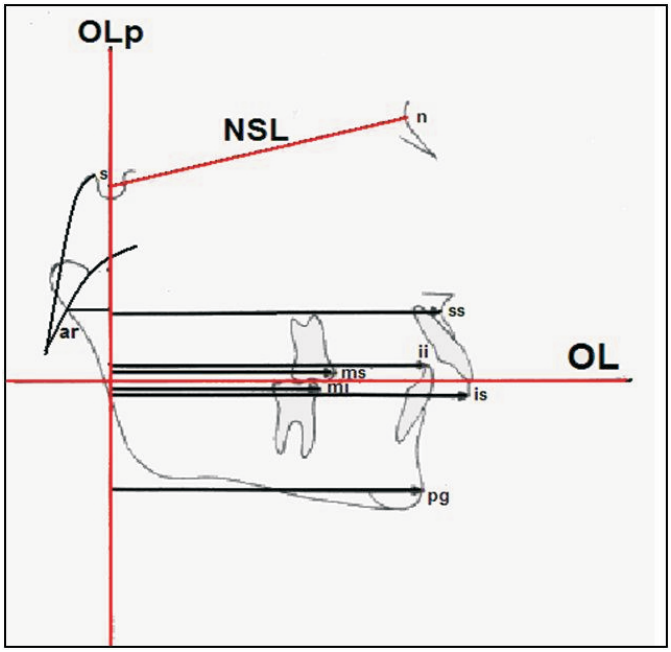

Fig (5) Measuring points and lines used in the linear cephalometric analysis. The registration line (NSL) and reference grid (OL and OLp) are shown.

Table II : The means, standard deviations (SD), and the results of paired t-test of the Cephalometric Linear Measurements before and after Appliance treatment period:

Measurements	Pretreatment		Posttreatment		Changes		Significance	
	Mean	SD	Mean	SD	Mean	SD	*t-value*	*P-value*
ss	82.65	7.05	82.45	7.31	0.2	0.63	1	0.34
pg	83.1	7.26	85.08	7.43	1.95	1.34	-4.59	0.001**
ar	7.95	1.92	7.1	1.80	0.85	0.41	6.52	0.000**
is	92.75	8.11	91.3	8.19	1.45	1.67	2.73	0.02*
ii	85.3	8.39	89.3	7.52	4	1.94	-6.50	0.000**
ms	58.6	5.96	58.8	6.08	0.2	0.42	-1.5	0.17
mi	57.7	6.21	60.2	6.14	2.5	1.43	-5.51	0.000**
is-ii	7.45	1.34	2	1.63	5.45	2.4	7.08	0.000**
ms-mi	1.8	1.54	0.1	2.18	1.7	2.16	2.48	0.04*
is-ss	10.6	2.01	9.05	1.67	1.55	1.83	2.67	0.03*
ii-pg	2.2	3.55	4.55	2.62	2.35	2.26	-3.28	0.01**
ms-ss	-23.25	1.93	-22.65	1.82	0.6	1.34	-1.40	0.19
mi-pg	-25.4	2.36	-24.55	2.31	0.85	1.73	-1.55	0.16
pg+ar	90.65	8.75	91.85	8.38	1.2	2.21	-1.71	0.12

SD = Standard Deviation
Not significant if $P > 0.05$
(*) = Significant if $P \leq 0.05$
(**) = Highly Significant if $P \leq 0.01$

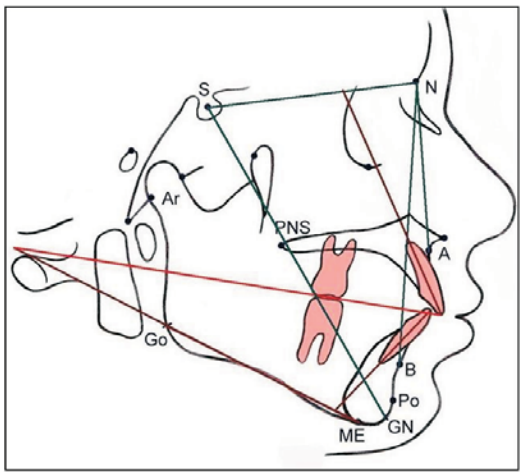

Fig (6) Reference points and lines used for the angular cephalometric analysis.

spring inserted in combination with the internal spring permits a greater active extension of force than any other appliances.[18]

INDICATIONS AND CONTRAINDICATIONS:

The SUS can efficiently treat a variety of Class II malocclusions. Currently, limited information is available in the literature on the use of the SUS.[18]

Indications:[17]

a) Class II correction including skeletal changes (Herbst effect).
b) Class II correction with dentoalveolar compensation of occlusion (Class II elastics effect).
c) Unilateral correction of Class II/ laterognathism.
d) Distalizing upper posterior teeth (headgear substitute).
e) Temporomandibular joint therapy (reposition effect).

Contraindications: [17]

a) Marked protrusion of lower anterior teeth.
b) Marked crowding of lower anterior teeth.
c) Severe gummy smile.
d) Poor oral hygiene.

MATERIALS AND METHODS

The sample of this study started with 13 patients of different sexes (7 females and 6 males), three dropped out and canceled and the rest (10) were considered

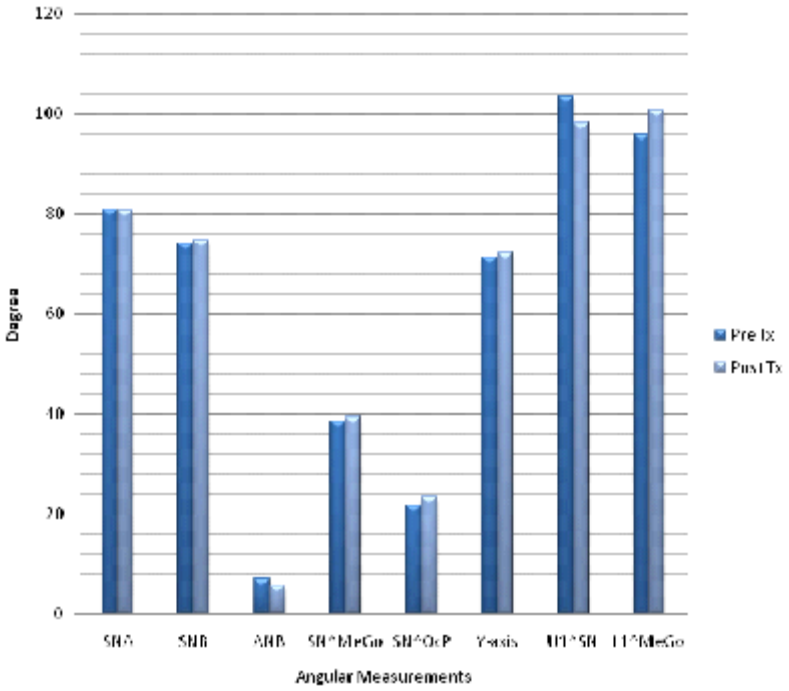

Fig (7) Angular cephalometric measurements of pre- and post-appliance treatment period.

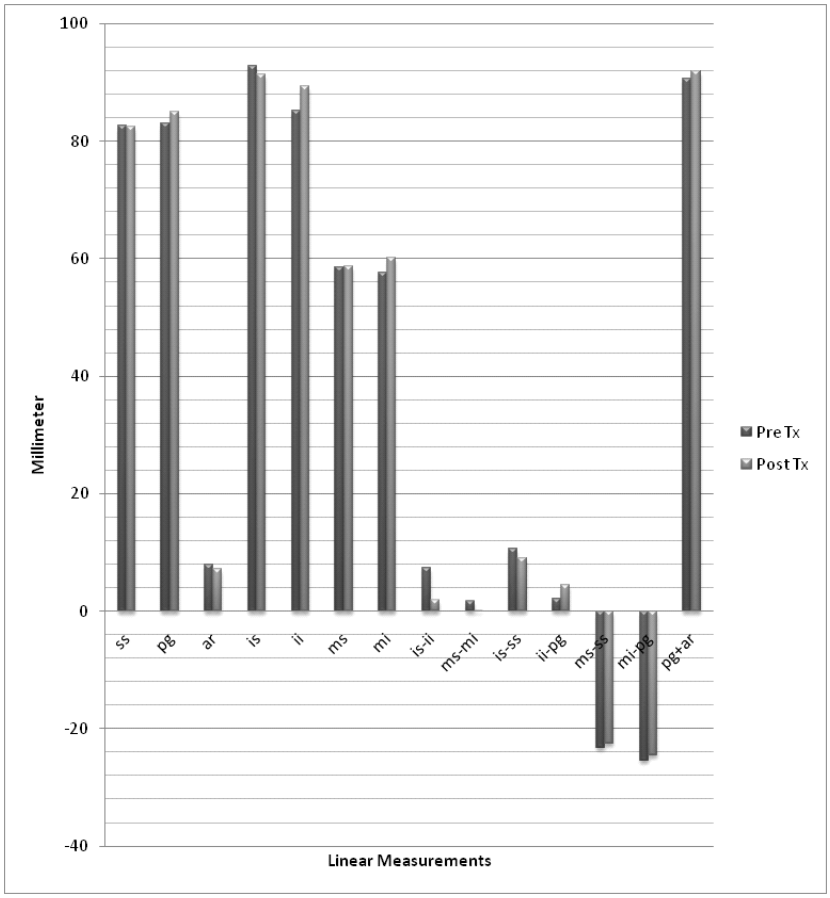

Fig (8) Linear cephalometric measurements of pre- and post-appliance treatment period.

the sample for this study. The appliance was applied on them after alignment and leveling period. All of the subjects are aged between 11 years and 14 years with an average age of 12 years and 2 months. At the beginning of the SUS[2] appliance treatment, their skeletal maturation age was assessed using the left-hand wrist x-rays. The skeletal maturation level of the patient is an important factor in the favorable response of the mandible. All SUS[2] patients in this study were subjected to a mean of seven months treatment period with the canine relationship corrected to Class I relationship or have exhibited an overcorrected incisor relationship at the time of appliance removal. Lateral cephalometric x-rays, photos and study models were taken before appliance application and after the treatment period. The cephalometric analysis was done according to Pancherz's linear analysis.[19] In addition, other angular measurements were utilized[6] (Fig 5 and Fig 6). The measurements before the insertion of the appliances were collected and compared with those after the treatment and the data were tabulated, statistically analyzed using SPSS program version 15.0 (SPSS Incorporated, Chicago, IL) and compared with the available readings of similar appliances. The statistical method used for the values was the paired t-test. The significance level was set at $P < 0.05$.

RESULTS:

The angular measurements determined before and after appliance treatment period treatment are shown in Table (I) together with the differences. Statistical deviations are marked with an asterisk (*) Fig (7).

Table (II) shows the results of the measurements before and after treatment together with the changes achieved by treatment with the SUS[2] (The linear analysis was done according to Pancherz)[19] Fig (8).

CASE PRESENTATION

Fig (9) Exra-oral frontal photographs of case no.1 showing pre and post treatment with SUS[2] appliance.

Fig (10) Exra-oral Lateral photographs of case no.1 showing pre and post treatment with SUS[2] appliance.

Fig (11) Intra-oral Frontal and Lateral views of case no.1 showing SUS[2] appliance insitu during appliance treatment period (overcorrection achieved).

Fig (12) Intra-oral frontal views of case no.1 showing pre and post treatment with SUS[2] appliance.

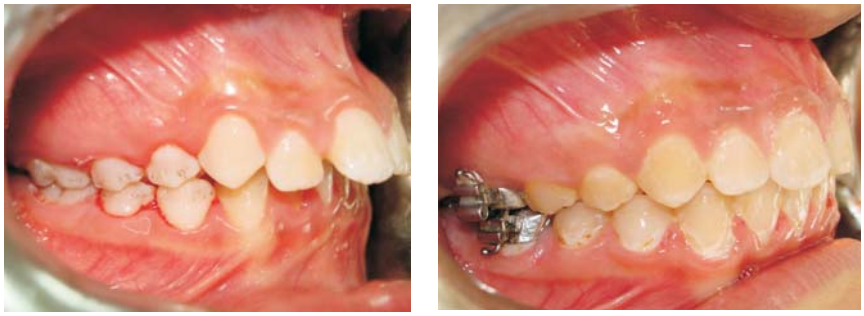

Fig (13) Intra-oral lateral right side views of case no.1 showing pre and post treatment with SUS^2 appliance.

Fig (14) Intra-oral lateral left side views of case no.1 showing pre and post treatment with SUS^2 appliance.

Fig (15) Intra-oral upper and lower arches views of case no.1 showing pre and post treatment with SUS^2 appliance.

DISCUSSION:

Class II malocclusion can be managed in three different ways: extraction, nonextraction with distal movement of the maxillary teeth into Class I, and orthognathic surgery with or without extraction of teeth. For the growing patient, nonextraction with growth modification may be the treatment of choice. Modification of growth is usually done by functional appliances, either removable or fixed.[18,20]

Sabbagh Universal Spring (SUS)^2 is a combination of the Herbst appliance and the Jasper Jumper aiming to increase the efficacy of the treatment and minimize their disadvantages. It has just one universal size and therefore can fit most of the patients with whatever mandibular advancement is needed. Moreover, it's considered a kind of hybrid fixed functional appliance which means it can produce a Headgear-like force effect or an elastic-like forces.[18, 21]

The purpose of this study was to clarify the possible effects of Sabbagh Universal Spring (SUS^2) on dental and skeletal measurements in the permanent dentition of growing patients and compare its effect with the available data of similar fixed functional appliances. Since the mechanics for both the Herbst, Jasper Jumper and Forsus have been the most investigated and documented in the fixed functional orthopedics, the results of this study were compared to them utilizing tables that were done by Heinig and Goz[6] that summarized the dental and skeletal changes reported in the literature relating to these two appliances. In addition to their research results on Forsus appliance [Appendix I and II] (see page 23), all other resources available were utilized as well.

The effect of treatment on the maxillary jaw base (ss/OLp) was less marked. When, however, the treatment changes are evaluated by means of angular measurements, the restraining effect of the SUS^2 appliance on maxillary growth seemed more pronounced. This may be explained by growth processes in the cranial base displacing the nasion (n) point more anteriorly, thus apparently affecting the SNA angle. SNA showed a statistically significant decrease. Use of the Herbst appliance in Class II patients appeared to have a restraining effect on the maxillary growth, as shown by a range of reduction 0.4-0.8° and with Jasper Jumper appliance the reduction range was 0.6-0.8° [Appendix I].[6] This result

Fig (16) Exra-oral frontal photographs of case no. 2 showing pre and post treatment with SUS^2 appliance.

Fig (17) Exra-oral lateral photographs of case no. 2 showing pre and post treatment with SUS^2 appliance.

Fig (18) Intra-oral frontal and lateral views of case no. 2 showing SUS^2 appliance insitu during appliance treatment period.

was in agreement with Pancherz.[5,19] During treatment with the SUS^2 spring, the mandible shifts anteriorly, since the mandible grows more in forward direction than the maxilla, the jaw relationship improved. There was slight, but statistically significant increase for SNB angle value from before to after appliance treatment period with a mean of 0.85.° The increase in sagittal mandibular growth was evident by the increase in the SNB angle which was found to be between 0.9° and 1.4° during Herbst treatment and Jasper Jumper treatment with range of 0.3°-1.2° [Appendix I].[6] These results were in agreement with the results after using Forsus spring[6] [Appendix II]. The forward position of the mandible (pg/OLp) found after SUS^2 appliance treatment was mainly a result of an increase in mandibular length (pg/OLp + co/OLp) which, in turn, was thought to be due to condylar growth stimulation in response to bite jumping, as has been verified in several animal experiments.[12] Forward displacement of the mandible leads to elongation of the muscle fibers and tendons. The pull of the muscle attachments at the bone surface is intensified by the modified function and induces bone remodeling processes.[12] The mandible as a whole was also somewhat displaced anteriorly by treatment (ar/OLp). This might be a result of remodeling processes in the articular fossa as a compensatory reaction to bite jumping. That was in agreemant with the significant increase in mandibular length reported in most of research studies which used the Herbst and Jasper Jumper appliances during treatment, there was an evidenced mandibular length increase up to 4.3 mm during treatment [Appendix I][6] and with the results during Forsus treatment period[6] [Appendix II].[6] The sagittal intermaxillary jaw relationship was also improved as evidenced by the significant reduction value for the ANB with mean of 1.25° between the pre-appliance treatment and post-appliance treatment results, as a result of the changes observed in the SNA and SNB angles, which could be attributed to the skeletal changes produced by the treatment. This finding was in harmony with most other studies.[11,12,17] On the other hand, a nonsignificant decrease in ANB angle was detected when using Forsus appliance.[6] This may be attributed to the difference in the appliance designs that have more dental than skeletal effects. Regarding the vertical dimension, SN^MeGo° and Y-axis° represented by the angle (S-Gn to S-N), it showed a statistically nonsignificant difference between pre- and post- SUS^2

Fig (19) Intra-oral frontal view of case no. 2 showing pre and post treatment with SUS2 appliance.

Fig (20) Intra-oral lateral right side views of case no. 2 showing pre and post treatment with SUS2 appliance.

Fig (21) Intra-oral lateral left side views of case no. 2 showing pre and post treatment with SUS2 appliance

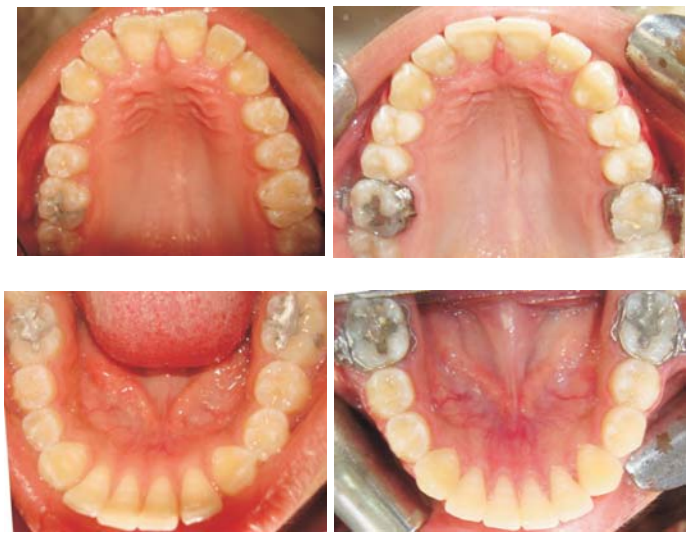

Fig (22) Intra-oral upper and lower arches views of case no. 2 showing pre and post treatment with SUS2 appliance.

appliance treatment period. This is in accordance with the findings of Pancherz[5,19] using the Herbst appliance, and supports as well the findings upon the usage of Forsus appliance.[6] There was a noticeable tipping of the occlusal plane which, measured at the anterior cranial base, the occlusal plane angle (SN^OcP°) showed a significant increase of 1.65° after the appliance treatment period using the SUS2 appliance. The

Fig (23) Extra-oral frontal photographs of case no. 3 showing pre and post treatment with SUS2 appliance.

Fig (24) Extra-oral lateral photographs of case no. 3 showing pre and post treatment with SUS2 appliance.

occlusal plane here underwent a rotation in terms of a bite opening. This opening movement is dentally induced. The pushing effect of the spring on the upper molars and on the lower incisors intrudes these teeth with consequent tipping of the occlusal plane. This was also reported in studies on the Herbst appliance with an increase of 1.1-2.8° [Appendix I][6] and with 2.4-3.2° increase was associated with Jasper Jumper [Appendix I].[6] This result was also in agreement with those of Heinig and Goz.[6] The upper incisor inclination (U1^SN°), (is/OLp) and (is-ss) showed a statistically significant reduction. This may be due to either the reciprocal distal force induced by the appliance on the maxilla as well as the maxillary dentition; consolidation of all teeth in the maxillary arch by means of a multibracket appliance into one unit shifts the point of force application downwards and backwards with respect to the unit's center of resistance; the torque effect of the preadjusted brackets or the altered position of the lower lip. Similar results were obtained by the Herbst appliance upon treating Class II division 1 malocclusion cases with a retroclination at a range of 6.6°-6.8° [Appendix I].[6] Retroclination of upper incisors is also an evident accompanying Jasper Jumper treatment at a range of 5.8° to 6.0°[Appendix I][6] and with Forsus with a mean of 5.33°[AppendixI I].[6]

Fig (25) Intra-oral frontal and lateral views of case no. 3 showing SUS^2 appliance insitu during appliance treatment period.

Fig (26) Intra-oral frontal views of case no. 3 showing pre and post treatment with SUS^2 appliance.

Fig (27) Intra-oral lateral right side views of case no. 3 showing pre and post treatment with SUS^2 appliance.

Fig (28) Intra-oral lateral left side views of case no. 3 showing pre and post treatment with SUS^2 appliance.

Mandibular incisors proclination represented by the increased incisors angle with the mandibular plane (L1^MeGo°), (ii/OLp) and (ii-pg). It was a significant finding after the appliance treatment period with a mean of 5°, 4mm and 2.35mm respectively, which could be attributed to the mesial component of force of the appliance since the force vector of a spring on a continuous mandibular arch is slightly above the center of resistance at the level of the clinical crown or the load of the lingual bar on the mandibular incisors and anchorage loss. The mandibular incisors were also affected by the Herbst treatment resulting in a proclination between 2.5° and 9.5° [Appendix I]. The increase in proclination of the lower incisors to the mandibular plane has also been a constant finding in the Jasper Jumper appliance which ranged from 4.2°-7.9° [Appendix I][6] and with Forsus, with a mean of 9.6° [Appendix II].[6] The overjet in the cast and cephalometric analyses (is-ss) was significantly improved in our study. That might be accounted for by both skeletal and dental changes in a sagittal direction, in which there was a restriction in mesial movement to the "ss" point, with retroclination of the maxillary incisors and probably a mesial movement of "pg" point, with proclination of the lower incisors. A significant decrease in the overjet was a constant result with all other functional appliances. For example, overjet reduction between 3.1 mm and 9.8 mm was evident at the end of the Herbst treatment. Also there is a range of 4.1-5.2 mm Overjet reduction associated with Jasper Jumper therapy [Appendix I].[6] After SUS^2 treatment, the overbite was found to be reduced significantly with a mean of 3.15 mm reduction after appliance treatment, which can be ascribed to the intrusion and protrusion of the lower incisors. This is a beneficial effect in the treatment of deep bites and anterior canting of the occlusal plane would help, in jumping the bite causing bite opening. Also an overbite reduction between 1.9 mm and 5.6 mm was evident at the end of the Herbst treatment.[2] For Jasper Jumper appliance different researches reported a reduction range of 1.1-

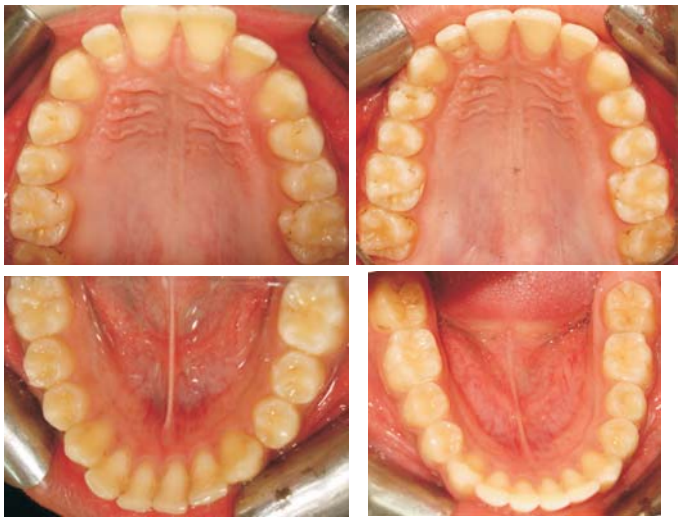

Fig (29) Intra-oral occlusal upper and lower arches views of case no. 3 showing pre and post treatment with SUS^2 appliance.

Fig (30) Extra-oral frontal photographs of case no. 4 showing pre and post treatment with SUS^2 appliance.

Fig (31) Extra-oral lateral photographs of case no. 4 showing pre and post treatment with SUS^2 appliance.

3.29 mm The reduction in overbite and overjet supports the incisor inclination variations caused by the appliance.[2] Forsus spring also caused reduction of the bite with a mean of 1.19 mm.[6] As in overjet above, a significant decrease in the overbite was a constant result with all other functional appliances. Regarding the upper molars position (ms/OLp) and (ms-ss), in the present investigation we found no significant distal movement of the upper molars; it almost remains at the same position. This may be a result of pre-planning a

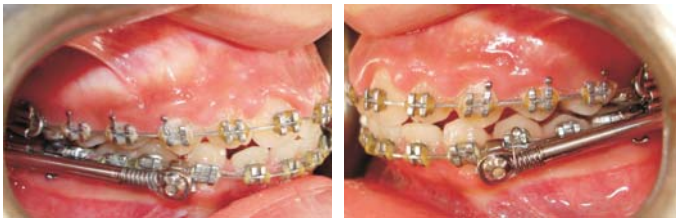

Fig (32) Intra-oral frontal and lateral views of case no. 4 showing SUS^2 appliance insitu during appliance treatment period (overcorrection achieved).

Fig (33) Intra-oral frontal views of case no. 4 showing pre and post treatment with SUS^2 appliance.

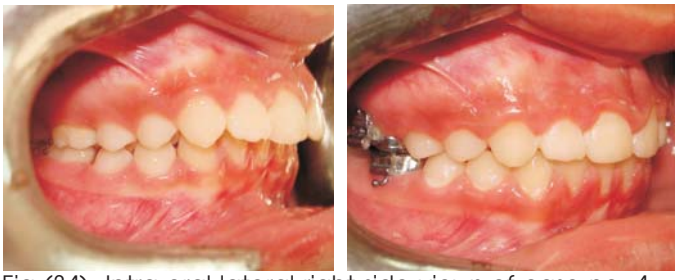

Fig (34) Intra-oral lateral right side views of case no. 4 showing pre and post treatment with SUS^2 appliance.

Fig (35) Intra-oral lateral left side views of case no. 4 showing pre and post treatment with SUS^2 appliance.

maximum anchorage of all our cases with cinched back heavy upper arch wire distal to the molars. If molars are allowed to move, they will probably have some degree of distalization. Regarding the influence of the Herbst appliance on the maxillary molars, distal molar movement between 1.3 and 2.9 mm [Appendix I][6] was observed during treatment. Similarly, the Jasper Jumper

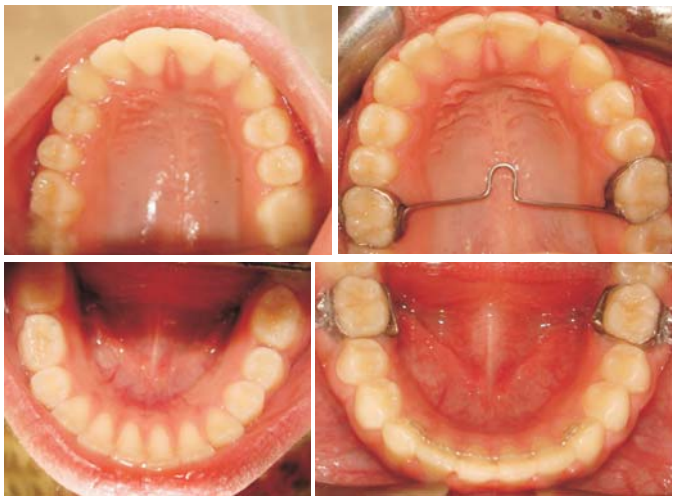

Fig (36) Intra-oral occlusal upper and lower arches views of case no. 4 showing pre and post treatment with SUS2 appliance.

Appendix- I

Angular measurements	Herbst	Jasper Jumper™
SNA	−0.4° to −0.6°	−0.6° to −0.8°
SNB	+0.9° to +1.4°	+0.3° to +1.2°
ANB	−1.3° to −2.5°	−1.0° to −2.0°
SN-MeGo	−0.2° to +0.7°	−0.3° to −1.2°
SN-OcP	+1.1° to +2.8°	+2.4° to +3.2°
Angle of inclination	+0.5° to +0.8°	+0.2° to +0.5°
Basal plane angle	−0.9° to +0.2°	−0.6° to −1.5°
U1–SN	−6.6° to −6.8°	−5.8° to −6.0°
L1-MeGo	+2.5° to +9.5°	+4.2° to +7.9°
Linear measurements		
ss	+0.2 mm to +0.8 mm	−0.1 mm to +0.5 mm
Pg	+1.9 mm to +4.3 mm	+1.4 mm to +2.2 mm
Is	−1.5 mm to −2.4 mm	−0.6 mm to −2.5 mm
ii	+2.8 mm to +6.0 mm	+2.9 mm to +3.1 mm
Ms	−1.3 mm to −2.9 mm	−0.9 mm to −1.5 mm
Mi	+2.1 mm to +5.1 mm	+2.6 mm to +3.7 mm
Ar	−0.3 mm to +0.1 mm	0.0 mm to −0.4 mm
Is-ii	−3.1 mm to −9.8 mm	−4.1 mm to −5.2 mm
Ms-mi	−5.7 mm to −9.3 mm	−3.4 mm to −5.0 mm
Is-ss	−0.5 mm to −3.3 mm	−1.5 mm to −2.4 mm
ii-pg	+0.5 mm to +3.4 mm	+0.8 mm to +1.5 mm
Ms-ss	−1.5 mm to −3.0 mm	−1.0 mm to −1.4 mm
mi-pg	+0.2 mm to +2.5 mm	+1.2 mm to +1.6 mm
Pg+ar	+2.0 mm to +4.0 mm	+1.4 mm to +1.7 mm

Compilation of changes observed in other studies after treatment with the Herbst appliance or the Jasper Jumper™ (quoted from Heinig and Goz).[15]

Appendix- II

	Before	After	Difference
SNA	80.88°	81.00°	+0.12°
SNB	76.21°	76.75°	+0.54° (*)
ANB	4.67°	4.25°	−0.42°
SN-MeGo	32.21°	32.06°	−0.15°
SN-OcP	15.81°	19.98°	+4.17° (*)
Angle of inclination	6.58°	6.56°	−0.02°
Basal plane angle	25.48°	25.52°	+0.04°
Y-axis	68.12°	67.98°	−0.13°
Facial height ratio	66.45%	66.41%	−0.04%
Index	79.09%	79.26%	+0.17%
U1-SN	101.88°	96.56°	−5.33° (*)
L1-MeGo	95.81°	105.41°	+9.60° (*)
ss	77.62 mm	77.94 mm	+0.32 mm
Pg	78.60 mm	80.04 mm	+1.44 mm (*)
ar	11.38 mm	11.12 mm	−0.27 mm
Is	83.46 mm	82.02 mm	−1.44 mm (*)
Ii	77.38 mm	80.65 mm	+3.27 mm (*)
Ms	54.83 mm	54.04 mm	−0.79 mm (*)
mi	53.65 mm	56.77 mm	+3.11 mm (*)
Is-ii	6.08 mm	1.37 mm	−4.71 mm
Ms-mi	1.18 mm	−2.73 mm	−3.91 mm
Is-ss	5.84 mm	4.08 mm	−1.76 mm
ii-pg	−1.22 mm	0.61 mm	+1.83 mm
Ms-ss	−22.79 mm	−23.90 mm	−1.11 mm
mi-pg	−24.95 mm	−23.27 mm	+1.68 mm
Pg+ar	89.98 mm	91.16 mm	+1.18 mm

Angular and linear variables measured on the lateral cephalo gram before and after treatment, and changes occurring during the treatment period with the Forsus™ spring (*p < 0.05). (quoted from Heinig and Goz).[15]

induced a range of 0.9 and 1.5 mm [Appendix I][6] distalization effect on the upper first molars. Regarding the position of the lower molars (mi /OLp), a significant change was found with a mean of 2.5 mm mesial molar movement. This could be explained by the telescope mechanism produced by an anterior-directed force on the lower teeth, resulting in mesial tooth movements in the mandible. Herbst therapy showed similar findings with a range of 2.1-5.1 mm mesial drift and with Jasper Jumper it ranged from 2.6-3.7 mm [Appendix I].[6] Forsus therapy showed a mean of 3.11 mm molar mesial movement [Appendix II].[6] The upper and lower molar relationship was improved. The (ms-mi) length was significantly decreased mostly due to mesialization of the lower dental arch rather than distal movements in the upper dental arch.

CONCLUSIONS:

The following conclusions could be drawn from this study:

1- The Sabbagh Universal Spring² appliance works well with the treatment philosophy of Class II division 1 malocclusion with retruded mandible where overjet reduction needs to be normalized by advancing the mandible anteriorly and if needed, distalizing the maxillary molars.

2- The changes found were mainly dental in nature with some contribution attributed to orthopedic effect. The dental influences of the appliance include retroclination of the upper incisors, proclination of the lower incisors, and mesial movement of the lower molar and canine.

3- Given the correct indications, we can say that bite jumping with the SUS² appliance is an effective way to treat adolescent patients and helps to reduce extractions and surgery, especially in borderline distal bite cases.

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