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SPLINT-SUPPORTED FORSUS FATIGUE RESISTANT DEVICE VERSUS CLASS II INTERMAXILLARY ELASTICS FOR THE CORRECTION OF CLASS II MALOCCLUSION; A RETROSPECTIVE STUDY

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Abstract

Objective: *To compare between the skeletal, dental, and soft tissue effects of the splint-supported FFRD and Class II intermaxillary elastics in growing patients with mild to moderate skeletal Class II malocclusion.*

Material and methods: *The Data of 20 growing females who were treated with either the splint-supported FFRD (10 patients, mean age 12.37±0.79) or Class II intermaxillary elastics (10 patients, mean age 12.55±0,88) were retrieved. They were treated till reaching an edge-to edge incisor relationship. Pretreatment and posttreatment cephalometric radiographs were traced and analyzed to compare between the 2 groups.*

Results: *The splint-supported FFRD showed some skeletal effects represented by significant decrease in SNA angle (-0.88±0.37), minor advancement of the mandible (SNB=0.52±0.27), and significant reduction in the ANB angle (-1.31±0.55). No statistically significant skeletal effects were found in the Class II elastics group. The maxillary incisors were more significantly retroclined in the splint-supported FFRD while more extruded in the Class II elastics group. The Class II elastics group showed more proclination of the mandibular incisors (11.75±6.78) compared to (8.88±1.35) in the splint-supported FFRD group, more extrusion of the lower molars (1.92±0.26) and more significant protrusion of the lower lip (1.32±0.56). The angle of convexity was only improved in the splint-supported FFRD group.*

Conclusion: *Both treatment modalities were successful in treating mild to moderate Class II growing patients. Skeletal effects; mainly headgear effect, were only observed in the splint-supported FFRD group, while only dentoalveolar effects were noted in the Class II intermaxillary elastics group.*

Keywords: *Splint-supported FFRD, Class II intermaxillary elastics, Class II.*

Introduction

Class II malocclusion due to mandibular deficiency is one of the most common malocclusions encountered in the Egyptian population representing about 20.6% in the age between 11 and 14 years.[1]

Many patients with skeletal discrepancies are not aware of their problem until they visit the orthodontist seeking alignment of their teeth. In many occasions, especially in growing patients, time is very critical to correct the skeletal problem. In cases with mild to moderate Class II malocclusion due to mandibular deficiency, the orthodontist then has to decide whether to use a removable functional appliance which needs good patient compliance in a critical time, or to start fixed

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appliance treatment followed by a fixed functional appliance or Class II elastics.

Fixed functional appliances have the advantage of solving the problem of patient compliance. On the other hand, adequate preparation through complete leveling and alignment of both arches is needed before their use which may result in delaying treatment and bypassing the critical time of active growth.[2]

The splint-supported Forsus Fatigue Resistant Device (Splint-supported FFRD) is an example of the splint mounted fixed Class II correctors that were first introduced in 1988. Other types include the splint type Herbst and the Cross bow (X-Bow) appliance.[3-5] They combine the advantage of being compliance free and at the same time can be used early once mandibular deficiency is detected, and therefore can help to catch the period of active growth needed for growth modification. The splint-supported FFRD uses the same spring that is used with the conventional FFRD, which is attached to a special maxillary and mandibular hybrid (acrylic/metal) splint that are specifically manufactured in the laboratory for each patient.[6]

Intermaxillary elastics is a commonly used inter-arch method to correct Class II malocclusion. Although the effects of Class II elastics are mainly dentoalveolar, including lingual tipping, retrusion, and extrusion of the maxillary incisors; labial tipping and intrusion of the mandibular incisors; mesialization and extrusion of the mandibular molars; and clockwise rotation of the occlusal plane[7-13], however, some skeletal effects were observed in some previous studies.[14,15] The major drawback of the intermaxillary elastics is that they totally rely on patient cooperation for their effectiveness, which can lead to poor treatment results and increased treatment time in case of poor cooperation.[16,17]

The splint-supported FFRD was compared to the conventional FFRD and was found to be equally effective in its dentoalveolar changes and additional maxillary restricting effect. In addition to the advantage of immediate start of treatment.[2]

The conventional FFRD has been previously compared to the Class II intermaxillary elastics and was found to be an acceptable substitute representing an effective and non-compliant option for the correction of Class II malocclusion.[14]

To our knowledge, no previous studies were carried to compare the splint-supported FFRD to Class II elastics.

Hence, this study was carried to compare between the skeletal, dental and soft tissue effects of the compliance free splint-supported FFRD and the Class II intermaxillary elastics which are totally patient reliant.

Material and Methods

This retrospective study was carried on a sample of 20 patients who were treated with 2 different Class II non-extraction methodologies. The records of the selected patients were recruited from the Orthodondic Department, Faculty of Dentistry- Ain Shams University. Each group of patients was treated by the same experienced orthodontist.

The sample was selected according to the following inclusion criteria:

- **Females 11-14 years of age**
- **Mild to moderate skeletal Class II (5≤ ANB ≥7), with retrognathic mandible (SNB $\leq$ 76)**
- **Active growth period confirmed by cervical vertebral maturation method (detected by pre-operative lateral cephalometry).**
- **Horizontal or normal growth pattern (Mandibular plane angle $\leq 30^0$)**
- **At least half unit unilateral or bilateral Class II canine relationship**
- **4 ≤ Overjet ≥ 7mm**
- **Permanent dentition stage with full set of permanent dentition in both arches**
- **Mandibular crowding less than 3 mm**
- **Normal or slight increased overbite**

Patients with the following criteria were excluded:

- Class II malocclusion due to maxillary protrusion only with a normal mandible

- Vertical growth pattern

-Posterior crossbite or tendency for posterior crossbite

-Systemic disease or syndromes affecting growth or craniofacial development

-Extracted or congenitally missing permanent teeth (except the third molars)

-Signs or symptoms of temporomandibular disorders

For the splint-FFRD group, the sample consisted of 10 females with a mean age of 12.37+ 0.79 years. A full splint was constructed for each arch using 0.9mm stainless steel wires that were adapted on the labial and lingual surfaces of the teeth. The splints were soldered to bands cemented on the first molars. For additional strengthening of the device, 0.7 mm stainless steel wires were added crossing the occlusal embrasure between the premolars on each side and were soldered to the labial and lingual wires. This metal framework was covered by 2mm of clear acrylic resin incisal and gingival to the wires and adapted to the labial and lingual surfaces of the teeth from canine to canine. The proper size of the FFRD was selected following the manufacturer's instructions. The pushrod of the FFRD was inserted distal to the end of the acrylic framework of the mandibular splint at the canine region of each side (Figure 1). The force level was checked will the patient was biting in centric occlusion, making sure of adequate compression of the FFRD spring to deliver the force described by the manufacturer's instructions (approximately 200 grams of force delivered with correct activation).

Fig 1. Intra-oral side view of splint-supported FFRD

For the intermaxillary elastics group, the mean age for the included sample of 10 females was 12.55+0.88 years. A non-extraction treatment protocol was carried for all the patients using 0.018 inch preadjusted fixed appliance. Treatment followed the same steps of comprehensive fixed appliance treatment starting by leveling and alignment. On reaching maxillary and mandibular heavy archwires; 0.017 x 0.025 inch stainless steel, correction of Class II canine and molar relationship was initiated using Class II intermaxillary elastics (1/4 inch-6 ounces). They were applied bilaterally from maxillary canine to mandibular first molars (Figure 2).

Fig 2. Intra-oral side view of Class II intermaxillary elastics

Follow up visits were scheduled every 4-6 weeks. In the splint FFRD group, a splint crimp was added on the pushrod to deliver the needed force. In the intermaxillary elastics group, the force level was measured each visit with a tension gauge while the patient was biting in centric occlusion to adjust the elastics size. Treatment was continued in both groups until over-correction to an edge-to-edge incisor relationship was achieved.

The study was conducted on lateral cephalometric radiographs that were acquired immediately before placement of any of the used appliances (T1), and after overcorrection and achieving an edge-to-edge incisor relationship (T2). Lateral cephalograms were analyzed using Dolphin Imaging 11.0 Software (Dolphin Imaging and Management solutions, Chatsworth, Calif).

For the splint FFRD group, fixed multibracket appliance was placed for final detailing and finishing. For the intermaxillary elastics group, final finishing and detailing was completed. Elastics for interdigitation were used when indicated.

To assess the reliability, all measurements were carried in a blinded manner by the same observer twice and by another observer. Cronbach's alpha reliability coefficient results showed very good intra-observer and inter-observer agreement with Cronbach's alpha value not less than 0.800 for all the variables.

Statistical analysis

All Data were collected, tabulated and statistically analyzed. Statistical analysis was performed utilizing SPSS software (version 20.0, IBM; Armonk, NY), while Microsoft office Excel was used for data handling and graphical presentation. Measured quantitative variables were described by the Mean, Standard Deviation (SD) for the preoperative (T1) and postoperative measurements (T2) as well as the mean differences between these measurements. Shapiro-Wilk test of normality was used to test normality hypothesis of all quantitative variables for further choice of appropriate parametric and non-parametric tests. The majority of the variables were found normally distributed leading to the use of parametric tests. Paired sample t-test was used to compare T1 and T2 measurements within each group. Independent sample t-test was used for comparing the difference (T2-T1) between the 2 groups. The significance level was set at $P < 0.05$.

Results

The changes between T1 and T2 in each group, as well as the comparison between the mean differences (T2-T1) of the measurements between the 2 groups are shown in Tables 1,2 and 3.

Skeletal changes

The splint-supported FFRD showed some skeletal effects represented by significant decrease in SNA angle (-0.88$\pm$0.37), minor advancement of the mandible (SNB = 0.52$\pm$0.27), and significant reduction in the ANB angle (-1.31$\pm$0.55), together with significant increase in the mandibular plane angle (SN/Go-Gn = 0.55$\pm$0.36). On the other hand, no statistically significant skeletal effects were found in the Class II elastics group.

Dental changes

The maxillary incisors were significantly retroclined in both groups but with more significant retroclination in the splint-supported FFRD group (-7.92$\pm$2.65) compared to (-3.66$\pm$1.92) in the Class II elastics group. Vertically, the maxillary incisors were extruded in the Class II elastics group (1.53$\pm$1.95). Although the mandibular incisors showed more proclination in the Class II elastics group (11.75$\pm$6.78) compared to (8.88$\pm$1.35) in the splint-supported FFRD group, but this difference was not statistically significant. The mandibular incisors were significantly intruded in both groups but with no statistically significant difference between both groups (P>0.05).

The maxillary molars were significantly distalized in both groups. However, they were intruded in the splint-supported FFRD group. The lower molars were extruded on both groups but with more significant extrusion in the Class II elastics group (1.92$\pm$0.26).

Both groups showed significant clockwise rotation of the occlusal plane, reduction in the overjet and overbite, all of which was not statistically significant between both groups(P>0.05).

Soft tissue changes

Both treatment groups showed a significant decrease in the distance between Eline to both the upper and lower lips but the distance to the lower lip was more significantly reduced in the Class II elastics group (1.32$\pm$0.56). The nasolabial angle was improved in both groups while the angle of convexity was only improved in the splint-supported FFRD group.

Table 1. Mean values of measurements at T1 and T2 and the mean difference (T2-T1) in the splint-supported FFRD group; Paired t-test.

Measurement	T1		T2		Mean diff.	SD	P value
	Mean	SD	Mean	SD			
Skeletal measurements							
SNA□	81.72	2.25	80.83	2.26	-0.88	0.37	<0.01*
SNB□	75.05	1.99	75.57	2.03	0.52	0.27	<0.05*
ANB□	6.74	1.03	5.43	1.35	-1.31	0.55	<0.01*
SN/Go-Gn□	30.82	1.74	31.37	1.84	0.55	0.36	<0.05*
Dental measurements							
U1/SN□	109.86	1.37	101.94	1.88	-7.92	2.65	<0.01*
U1-FH mm	11.29	1.72	10.71	1.59	-0.59	0.61	0.0062
L1/MP□	101.45	1.27	110.33	0.86	8.88	1.35	<0.001*
L1-MP mm	25.76	2.14	23.43	2.28	-2.33	0.68	<0.01*
U6-PTV mm	41.12	2.00	40.20	1.72	-0.91	0.87	<0.05*
U6-FH mm	31.22	2.80	30.07	3.15	-1.15	0.73	<0.05*
L6-MP mm	17.87	2.25	18.76	2.31	0.89	0.12	<0.001*
Occlusal plane/SN□	16.68	2.19	19.74	4.18	3.06	2.27	<0.05*
Overjet	6.20	0.94	1.71	0.72	-4.49	0.58	<0.001*
Overbite	4.51	0.80	0.80	0.35	-3.70	0.62	<0.001*
Soft tissue measurements							
UL-Eline mm	2.28	0.77	1.40	1.17	-0.87	0.58	<0.05*
LL-Eline mm	-0.06	1.14	0.57	0.87	0.63	0.35	<0.05*
Nasolabial angle	109.25	14.81	113.03	14.20	3.79	1.35	<0.01*
Angle of Convexity	1.55.85	3.69	156.74	3.84	0.89	0.47	<0.05*

*, Significant at P < 0.05

Table 2. Mean values of measurements at T1 and T2 and the mean difference (T2-T1) in the Class II intermaxillary elastics group; Paired t-test.

Measurement	T1		T2		Mean diff.	SD	P value
	Mean	SD	Mean	SD			
Skeletal measurements							
SNA°	80.24	1.93	80.08	2.06	-0.16	1.63	0.30425
SNB°	75.11	1.16	75.16	1.65	0.05	1.11	0.92456
ANB°	5.13	0.90	4.62	1.63	-0.51	1.52	0.25191
SN/Go-Gn°	29.46	0.80	30.60	2.07	1.14	1.63	0.19507
Dental measurements							
U1/SN°	107.98	3.76	104.32	2.76	-3.66	1.92	<0.05*
U1-FH mm	10.86	1.12	12.38	2.54	1.53	0.95	<0.05*
L1/MP°	94.01	7.03	105.76	11.19	11.75	6.78	<0.05*
L1-MP mm	22.76	1.18	20.38	4.07	-2.38	3.78	<0.05*
U6-PTV mm	40.16	0.52	39.30	0.76	-0.86	0.34	<0.01*
U6-FH mm	30.68	1.88	31.71	1.43	1.03	1.52	0.15448
L6-MP mm	18.64	2.13	20.56	2.31	1.92	0.26	<0.001*
Occlusal plane/SN°	16.93	2.33	20.23	3.86	3.31	1.98	<0.05*
Overjet	5.71	1.39	2.34	1.07	-3.36	2.23	<0.05*
Overbite	4.57	0.92	0.75	0.49	-3.82	0.90	<0.001*
Soft tissue measurements							
UL-Eline mm	2.25	0.68	1.41	0.84	-0.83	0.49	<0.05*
LL-Eline mm	-0.52	1.49	0.80	1.38	1.32	0.56	<0.01*
Nasolabial angle	111.72	4.70	115.80	4.95	4.08	2.97	<0.05*
Angle of Convexity	156.46	3.05	157.60	3.98	1.14	1.22	0.10528

*, Significant at $P \leq 0.05$

Table 3: Comparison of the mean differences (T2-T1) of the measurements between the 2 groups; Independent sample t-test.

Measurement	Splint-supported FFRD		Class II elastics		Mean diff.	SD	P value
	Mean	SD	Mean	SD			
Skeletal measurements							
SNA□	-0.88	0.37	-0.16	1.63	-0.72	0.75	<0.01*
SNB□	0.52	0.27	0.05	1.11	0.47	0.51	0.38032
ANB□	-1.31	0.55	-0.51	1.52	-0.80	0.72	<0.01*
SN/Go-Gn□	0.55	0.36	1.14	1.63	-0.59	0.75	0.45322
Dental measurements							
U1/SN□	-7.92	2.65	-3.66	1.92	-4.26	1.46	<0.05*
U1-FH mm	-1.59	0.621	1.53	1.95	-3.11	0.91	<0.01*
L1/MP□	8.88	1.35	11.75	6.78	-2.87	3.09	0.38039
L1-MP mm	-2.33	0.68	-2.38	3.78	0.05	1.72	0.97661
U6-PTV mm	-0.91	0.87	-0.86	0.34	-0.05	0.42	0.91156
U6-FH mm	-1.15	0.73	1.03	0.52	-2.18	0.40	<0.001*
L6-MP mm	0.89	0.12	1.92	0.26	-1.03	0.13	<0.001*
Occlusal plane/SN□	3.06	2.27	3.31	1.98	-0.25	1.35	0.85957
Overjet	-4.49	0.58	-3.36	2.23	-1.13	1.03	0.30642
Overbite	-3.70	0.62	-3.82	0.90	0.12	0.49	0.81527
Soft tissue measurements							
UL-Eline mm	-0.87	0.58	-0.83	0.49	-0.04	0.34	0.90416
LL-Eline mm	0.63	0.35	1.32	0.56	-0.69	0.30	<0.05*
Nasolabial angle	3.79	1.35	4.08	2.97	-0.29	1.46	0.84639
Angle of Convexity	0.89	0.47	1.14	1.22	-0.25	0.59	0.67820

*, Significant at P < 0.05

Discussion

Patients with skeletal problems who present to the orthodontist at the end of their pubertal growth spurt usually make the choice of the appropriate treatment strategy challenging. The amount of growth remaining, the severity of malocclusion, the stage of dental development, and the degree of patient cooperation are all factors that should be considered during making the decision. The splint-supported FFRD offers several advantages that gives it a priority to be one of the first options in the treatment of skeletal Class II cases; it can be used in the late mixed dentition stage immediately without the need to wait till the eruption of all permanent teeth, or to wait for levelling and alignment needed before the use of either fixed functional appliances or Class II elastics. This delay can waste the critical time needed for growth modification. Moreover, it is a compliant free appliance unlike the other available options. This study was carried to compare between this promising appliance and Class II intermaxillary elastics which is commonly used in our daily practice.

In this study, only females were included to exclude any inaccuracy caused by the different timing and rates of growth between different genders.

Presence of some skeletal effects for the splint-supported FFRD represented by a significant reduction in the SNA angle, minor mandibular advancement, and a significant decrease in the ANB angle has been reported before in previous studies.[2,6,18] This maxillary restricting effect resembling the headgear effect together with the significant reduction in the ANB angle indicates improvement of the skeletal Class II relationship. This could be explained by the design of the splint-supported FFRD; the rigid connection between the maxillary dental arch and the FFRD spring allowed the transmission of the distalizing forces to the maxillary alveolus causing its distal and backward movement. On the other hand, the skeletal effects of Class II intermaxillary elastics were controversial. In this study, there were no significant skeletal effects that was in accordance with other studies.[13,19,20] However, some previous studies reported some skeletal effects with the use of Class II elastics represented by anterior mandibular displacement [14], while others reported restriction of maxillary anterior growth.[15]

Although both groups showed significant retroclination of the maxillary incisors, but it was more significant in the splint-supported FFRD group. This could be explained by the presence of full thickness archwire in the bracket slots of the multibracket appliance of the Class II elastics group, that was resistant to the tipping forces more than the splint group where the teeth were more free to tip palatally than in the elastics group. The extrusion of the maxillary incisors in the Class II elastics group is a typical finding that was reported in previous studies.[7-13]

The mandibular incisors were proclined in both groups but with more significant proclination in the Class II elastics group. Absence of skeletal effects in the Class II elastics group explains the cause of more dental compensation seen in this group to reach Class I dental relationship. This proclination in the mandibular incisors was consistent with other studies[7-13] Vertically, the mandibular incisors were intruded in both groups. As the mandibular incisors get proclined, the vertical distance from the tip of the incisors to the mandibular border is expected to decrease in proportion to its proclination.

The extrusion of the mandibular molars was more with the Class II elastics group similar to other studies.[7-13] The limited extrusion of the mandibular molars seen in the splint-supported FFRD group could be explained by the vertical control produced by the occlusal cross wires present in the premolar region.

The finding of extrusion and palatal tipping of the maxillary incisors together with extrusion of the mandibular molars found in the Class II elastics group could be explained by the vertical component of the vector of the elastics force as reported previously.[9,21]

Although some minor skeletal effects were found in the splint-supported FFRD group, however, the decrease in the overjet in both groups was mainly due to the significant retroclination of the maxillary incisors and proclination of the mandibular incisors.

Regarding the soft tissue changes, the more proclination of the mandibular incisors seen in the Class II elastics group could explain the more significant forward movement of the lower lip in this group. Moreover, the angle of convexity was more improved in the splint-supported FFRD group due to the minor skeletal effects found in this group.

According to the results of the current study, both treatment strategies were able to correct the canine and molar relationships into Class I and correct the increased overjet in patients with mild to moderate skeletal Class II malocclusion, who present at the end of their pubertal growth spurt. However, whenever there is a chance to start with the splint-supported FFRD, this will help to initiate some skeletal effects, mainly a maxillary restricting headgear effect, which will help to improve the profile and decrease the dental compensations. It has the advantage that it can be inserted immediately without the delay needed for levelling and alignment that can waste the critical time needed for growth modification. Moreover, it is a fixed functional appliance that does not rely on patient cooperation, that is another risk to catch the critical period of active growth. However, if the patient came late to seek treatment and Class II intermaxillary elastics was the treatment of choice, it can also produce satisfactory dental effects and acceptable occlusion in cooperative patients.

Limitations

Being a retrospective study, analyzing pre-existing data in itself is a limitation that provides inferior level of evidence compared to prospective studies. Moreover, the small sample size is another limitation that can affect the results. Evaluating the long-term effects of the splint-supported FFRD after second phase of fixed appliance treatment, and comparing it to the effects of Class II intermaxillary elastics also will provide valuable information.

Conclusion

Both treatment modalities were successful in treating mild to moderate Class II growing patients. Skeletal effects; mainly headgear effect, were only observed in the splint-supported FFRD group, while only dentoalveolar effects were noted in the Class II intermaxillary elastics group.

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