Efficacy of the Mini-Plate Anchored Herbst Appliance Versus the Dentally Anchored Fixed Functional Appliance in Young Adult Class II Orthodontic Patients; aRandomized Clinical Trial

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Abstract

Objective: to compare the dentofacial effects of skeletally anchored Herbst appliance versus dentally anchored Twin Force Bite Corrector appliance to treat skeletal class II young adult orthodontic patients.

Materials and Methods: the current study was performed on 20 orthodontic Class II young adult patients with their age ranged between 16 and 20 years, divided into two groups; ten patients were treated by a Twin Force Bite Corrector appliance, while the other ten patients were treated by Herbst appliance anchored by two mini plates.

Results: bycomparing the two groups regarding the amount of change in cephalometric measurements, there was no statistically significant difference between both groups except in IMPA, where the Herbst group recorded a statistically significant decrease (5.14%) (p=0.005). Also, a significantly higher percent increase was recorded in the Herbst group regarding soft tissue convexity angle (p=0.023), and a substantially higher percent decrease was recorded in the TFBC group regarding overjet (p=0.011).

Conclusion: The skeletally anchored Herbst appliance and the dentally anchored Twin force bite corrector produce successful correction for class II malocclusion in young adult patients, but the Herbst appliance depends on its skeletal effect, which is expressed in significant soft tissue profile improvement. In contrast, the TFBC depends on its dentoalveolar effects.

Keywords: Mini plates; class II malocclusion; fixed functional appliance; TFBC; Herbst.

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INTRODUCTION

One of the most common complaints in orthodontic clinics is skeletal class II malocclusion whichrepresents 12% to 49% of all orthodontic problems[1]. Class II malocclusion combines dental and skeletal components that affect the patient's profile[2]. This malocclusion may be due to maxillary protrusion, mandibular retrusion, or a combination of both[3]. Class II malocclusion with retruded mandible has a noticeable adverse effect on the soft tissue profile of the patient[4].

Different treatment modalities for class II malocclusion with retrognathism of the mandible were concerned with increasing the mandibular length throughstimulation of condylar growth and fossa remodeling[5, 6]. This was achieved by using removable or fixed functional appliances. Still, thereare controversies about the skeletal or dentoalveolar effects of the fixed functional appliance, however recently there are many studies revealed skeletal correction of class II malocclusion combined with mandibular retrognathism in adolescent patients by using fixed functional appliances[7-9].

The Twin Force Bite Corrector is a semi-rigid fixed functional appliance which is introduced by Jeff Rothenberg in 2004[10]. The TFBC is composed of two telescopic parts with internal NiTi coil springs. The appliance is fixed to maxillary and mandibular fixed appliance archwires. It is locked at the mesial

surface of the maxillary molars tube and the distal surface of the mandibular canines brackets using a specialized, provided screwdriver[11]. Previous studies used a force gauge; the Twin Force Bite Corrector exerts an average compression force of 210 g for each side[12, 13].

The Herbst appliance is a fixed functional bite-jumping appliance for treating class II malocclusion with mandibular retrognathism producing jumping mandibular forward posture to correct the skeletal Class II anteroposteriormal-relationship.However, few previous studies proved its effectiveness on the clinical outcomes for adolescent patients[14-16].

One of the main drawbacks of fixed functional appliances is the proclination of the lower incisor teeth,which prevents the skeletal effect of those appliances[17, 18]. To overcome this limitation, mini-screwswere used with the FFA. Still, the success rate of mini-screws in the mandibular arch is very low when compared with the maxillary one, which led to some complications in the end results[19, 20].

To avoid the failure of mini screw supported fixed functional appliances, mini plates anchored Forsus FRD was introduced[21,22], which revealed a high success rate in producing a skeletal effect without proclination of lower incisor teeth, and although Herbst appliance is considered as the best FFA due to stability of its dentoskeletal effect[23].

In young adult patients, there are two treatment approaches; either compensation of the dentition to camouflage the underlying skeletal malocclusion or surgical correction of the presenting skeletal discrepancy[24]. However, when considering the fact that skeletal growth continues after cessation of body height growth and that the adult TMJ can be stimulated and reactivated for remodelingat this later age, it will be possible to widen the range of growth adaptation with fixed functional orthopedic appliances to include young adult patient[25,26]. Based on this fact, the current study depended on a comparison of dentofacial effects of mini-plate anchored Herbst appliance versus dentally anchored Twin Force Bite Corrector in young adult patients. The current study is free from bias, stereotypes, slang, and reference to the dominant culture and/or cultural assumptions.

MATERIALS AND METHODS

- **Study Design**

A prospective parallel randomized clinical study.

- **Intervention**

The orthodontic patients involved in this study were treated by using fixed orthodontic appliances followed by one of two different types of fixed functional appliances; the type IV Herbst appliance (miniplate anchored appliance) and the Twin Force Bite Corrector (dentally anchored appliance).

- **Study setting and population**

This prospective randomized clinical parallel study was conducted on twenty orthodontic patients selected from different orthodontic centers. The Herbst group (Group I) included ten young adult patients treated by mini-plate anchored type IV Herbst appliance (Dentaurum GmbH &Co.KG, Germany),while the TFBC group (Group II) included 10 young adult patients treated by dentally anchored Twin force bite corrector (Ortho Organizer, inc, 1822 Aston Avenue, HenryScheinOrtho.com, USA).

- **Sample size calculation:**

The number of patients was dependent on a power study derived from a previous study[21], with an allocation Ratio: of 1:1. The calculation indicated that for a prospective randomized clinical study with an estimated effect size of 1.3678606, Tail(s) = Two, Allocation ratio N2/N1 = 1, Output: Non-centrality parameter $\delta = 3.0586293$, a power of 0.80 and an alpha of 0.05, a total sample of 20 patients is required (10 patients in each group).

Formula:

$$n = \frac{16}{\left(\frac{\Delta}{\sigma}\right)^2} = \frac{16}{(\text{effect size})^2} = \frac{16}{\delta^2}$$

Effect size (δ) is the standardized difference — the absolute difference Δ divided by the standard deviation σ.

- **Inclusion Criteria**

The inclusion criteria were (1) Class II malocclusion with mandibular retrusion (ANB = 5 - 8^o).(2) Increased Overjet ≥ 5.0 mm. (3) Normal or horizontal, vertical facial growth patients. (4)All enrolled patients must be with their full permanent dentition except the third molars. (5) The patients included in the current study should be young adult patients with ages ranging from 16 to 20 years.

- **Ethical Consideration**

The current study was approved by Ethical committee of Faculty of Dental Medicine, Cairo, boys, Al – Azhar University. The Ethical code for the present study is **586/307**. The present study was registered in clinical trials.gov PRS by ID **NCT05440526.**All patients involved in the current study have signed informed consent form that describes each step of treatment.

According to the type of fixed functional appliance, the patients were randomly divided into two groups. The random allocation will be achieved by computer software:

- **Group I:** Include ten young adult orthodontic patients who are treated by the type IV Herbst appliance (mini plate anchored appliance)

(Dentaurum GmbH &Co.KG, Germany), this is followed by using fixed orthodontic appliances. The age of the patients was(16-20y).

- **Group II:** Include ten young adult orthodontic patients who are treated by using fixed orthodontic appliances followed by the Twin Force Bite Corrector appliance (dentally anchored appliance). The age of the patients was (16-20y).

- **Groups randomization**

Patientswere assigned into these two groups through a simple online generated randomization plan by using online software found at the website http://www.graphpad.com/quickcalcs/index.cfm.

- **Records**

The following diagnostic records were taken for each patient before and after the fixed functional orthopedic treatment:

1. Standardized study casts.
2. Standardized extra-oral and intra-oral photographs.
3. Lateral cephalometric and panoramic radiographs.

- **Treatment steps**

As for Group I (Herbst Group):**(Figure 1)**

a) Two mini plates are chosen; the last hole in every plate is used for soldering the ball housing of the type IV Herbst appliance.

b) The two mini plates are placed bilaterally at the mandibular symphysis and fixed by at least three screws. Surgical installation of the mini plates was carried out under localanesthesia, the envelope flap extending apically to the symphysis level to allow unstrained installation of the mini plate.The surgical wound is sutured, leaving an extended part of the plate in the oral cavity, which contains the soldered ball housing.

c) The surgical wound is left for two weeks for proper soft tissue healing; in the meantime, separation in the maxillary arch and band placement on the first premolars and first and second molars bilateral, followed by an impression for construction of the upper Herbst splint.

d) Cementation of the upper Herbst splint was done, which contains the plunger soldered to the first molar at the buccal tube position (the buccal tube was removed from the start since plain bands hadn't been found in the market). After the complete sitting of the cement, the telescopic piston was connected to the upper plunger from one side and to the ball attachment soldered to the mini-plates in the mandible from the other side.

e) When reactivation of the telescopic piston is needed, extension rings are used.

f) As for appliance removal, it was removed after nine months**,** andthe mini plates were removed by another surgery.The patients will Complete the orthodontic treatment withthe fixed appliance to reach firm occlusion.

Figure 1: Surgical insertion of the mini plates followed by installation and cementation of Herbst appliance type IV.

As for Group II (TFBC Group):**(Figure 2)**

a) The patients will be treated by a fixed orthodontic appliance using a series of orthodontic NiTi arch wires for leveling and alignment; this is preceded by the installation of transpalatal arch for the upper Jaw.
b) Installation of a series of orthodontic stainless steel archwires until 0.0019 x 0.0025-inch stainless steel wire for both arches.
c) Consolidation of the upper and lower dental arch by figure 8 ligature wire 0.0010
d) Installation of the Twin Force Bite Corrector appliance for 4 to 6 months to achieve an

incisal edge-to-edge position in one-step advancement.

e) Using class II intra-oral elastics for both sides for 2 to 3 months.

f) Finally, follow the finishing steps for each patient.

Patients of both groups were recalled every two weeks after fixed functional appliance insertion to check for the following; soft tissue irritation, oral hygiene measurements, looseness of the appliances or mini plates and any signs or symptoms of TMJ upsets.

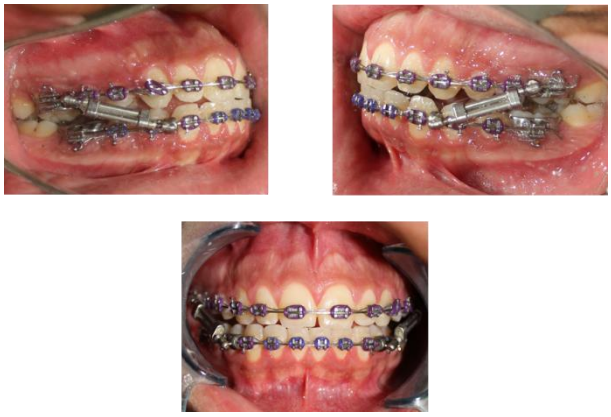


Figure 2: Installation of Twin force bite corrector.

- **Observations- (Figure 3)**

Changes in the linear and angular cephalometric measurements (skeletal, dentoalveolar, and soft tissue) before and after the fixed functional orthopedic treatment at each group. These cephalometric measurements are; SNA, SNB, ANB, Facial angle, Co – A, Co – Gn, FMA, U1 – SN, IMPA, overjet and overbite, soft tissue convexity angle and upper lip to E-line. The cephalometric analysis was performed by Dolphin Ceph Tracing software.

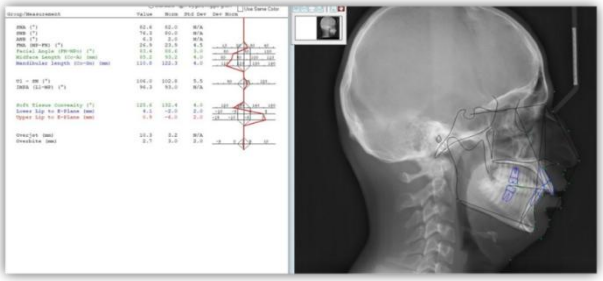


Figure 3: Cephalometric analysis for required measurements at study groups.

- **Outcomes**

The primary outcome was the dentofacial effects of the skeletally anchored Herbst appliance versus the dentally anchored Twin Force Bite Corrector appliance for the treatment of skeletal class II malocclusion in young adult patients. The secondary outcome was the assessment amount of change in cephalometric measurements within each group before and after treatment.

- **The error of the study:**

To assess measurement reliability, ten lateral cephalometry were randomly chosen, and then the dentofacial readings were remeasured one month after the first measurement. Reliability was evaluated using intraclass correlation (ICC), which gave strong intraexaminer reliability (ICC ¼ 0.998), and the Dahlberg formula, which showed a minimal error that does not affect the reliability of the measurements.

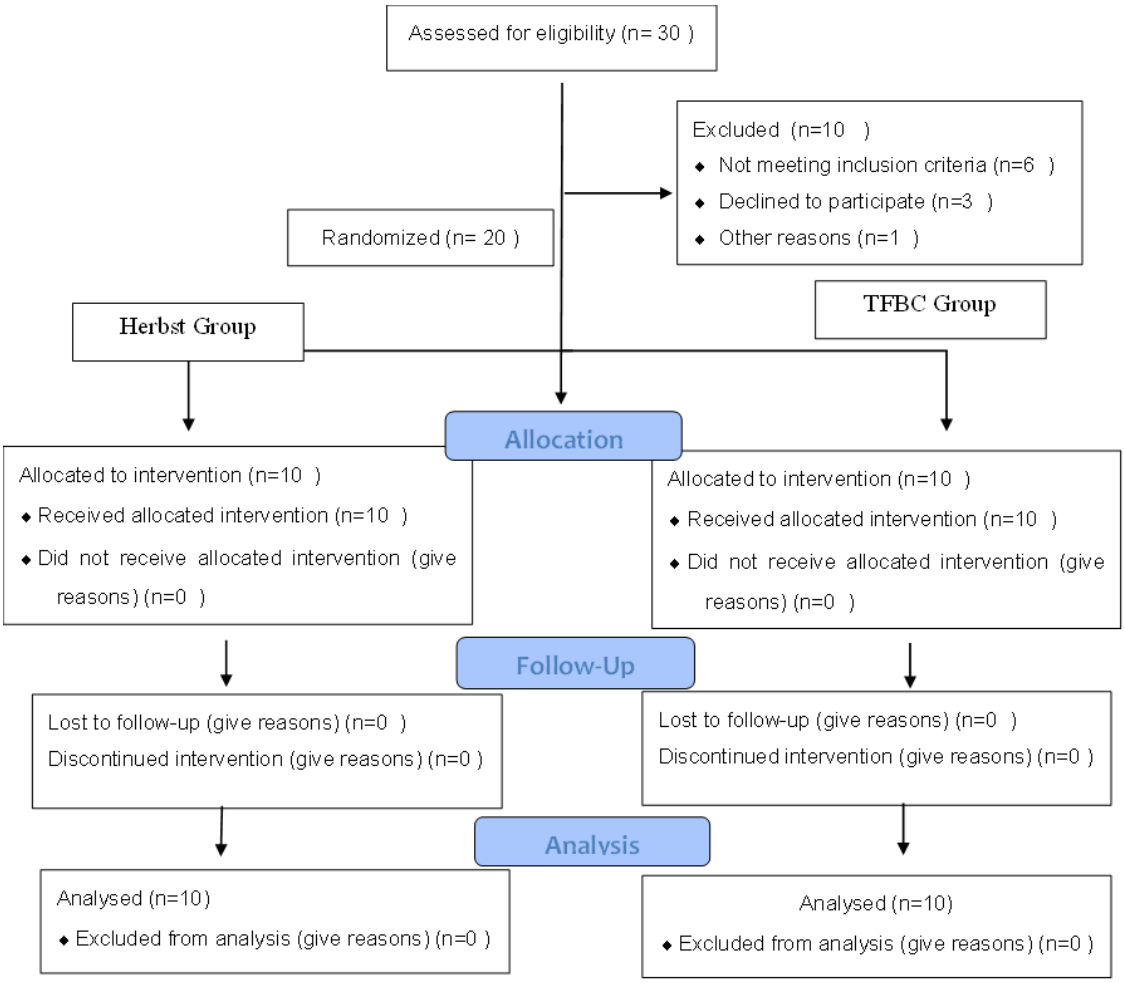
- **Statistical analysis:**

Data management and statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) version 18. Numerical data were summarized using means and standard deviations. Data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests.
Comparisons between groups with respect to customarily distributed numeric variables were performed by independent t-test, while non-parametric variables (percent change) were compared by the Mann-Whitney U test. Comparison between pre and post-observations was performed using paired t-test. The percent

change was calculated by the formula: (value after-value before) / value before X100. All p-values are two-sided. P-values ≤0.05 were considered significant.

RESULTS

All twenty patients who met inclusion criteria had a complete analysis for required cephalometric measurements before and after treatment by fixed functional appliances. There is no participant enrolled in the present study which has dropped out (see participant flow diagram). Each participant has a follow-up every three weeksat the orthodontic clinic.



Participants flow diagram

As for the comparison between the two groups, pretreatment cephalometric measurements showed a non-statistically significant difference between the Herbst group and TFBC group except for FMA (MP-FH), where the Herbst group recorded a significantly higher value (p =0.023)**(Table 1, Figures 4, 6).**Also, post-treatment cephalometric measurements showed a non-statistically significant difference between the Herbst group and TFBC group except for overjet that revealed a statistically significant decrease after treatment with the Herbst group(4.56±1.84) than TFBC group(2.49±0.57), (p=0.006). **(Table 1, Figures 5, 7)**

As for the comparison between the two groups regarding the amount of change in cephalometric measurements before and after treatment, there was no statistically significant difference between both groups except in IMPA, where the Herbst group recorded a statistically significant decrease than TFBC group (5.14%), (p=0.005). Also, a significantly higher percent increase was recorded in Herbst regarding soft tissue convexity (p=0.023),and a significantly higher percent decrease was recorded in TFBC regarding overjet (p=0.011). **(Table 2, Figure 8).**

As for Comparison between before and after treatment recorded values within each group, SNA and Facial Angle showed no significant difference after treatment within each of the studied groups. SNB (p=0.005),(p=0.000),mandibular length (Co-Gn)(p=0.00), (p=0.0025) and Soft Tissue Convexity angle(p=0.004), (p=0.007) were significantly increased while ANB (p=0.000),(p=0.000), overjet (p=0.000), (p=0.000)

and Upper Lip to E-Plane distance(p=0.000), (p=0.0011) were significantly decreased after treatment in both groups. FMA and IMPA showed no significant difference after treatment within the Herbst group but significantly increased in the TFBC group (p=0.035), (p=0.005), respectively. Midface length (Co-A) significantly decreased after treatment in Herbst (p=0.0033) but significantly increased after treatment in TFBC (p=0.004). U1-SN showed no significant difference after treatment within the TFBC group but significantly decreased in the Herbst group (p=0.0015). Lower Lip to E-Plane distance showed no significant difference after treatment within the Herbst group but significantly decreased in the TFBC group(p=0.005). The overbite showed no significant difference after treatment within the TFBC group but significantly decreased in the Herbst group (p=0.0028).**(table 1).**

Table (1) Comparison between groups (independent t test) and within group (Paired t test):

Groups		pre		Post		P value within group
		Mean	Std. Dev	Mean	Std. Dev	
SNA	Herbst	80.79	4.10	80.61	4.11	.744 ns
	TFBC	81.31	4.30	81.02	4.73	.355 ns
	P(bet.)	.785 ns		.838 ns		
SNB	Herbst	73.66	3.75	75.94	3.70	.005*
	TFBC	75.32	4.12	76.89	3.69	.000*
	P(bet.)	.359 ns		.572 ns		
ANB	Herbst	7.12	2.07	4.67	2.03	.000*
	TFBC	5.96	1.07	4.57	1.69	.000*
	P(bet.)	.139 ns		.906 ns		
FMA (MP-FH)	Herbst	29.94	6.25	31.22	6.64	.089 ns
	TFBC	24.07	3.81	26.20	3.47	.035*
	P(bet.)	.023*		.053 ns		

Table (1 cont.) Comparison between groups (independent t test) and within group (Paired t test):

Groups		pre		Post		P value within group
		Mean	Std. Dev	Mean	Std. Dev	
Facial Angle (FH-NPo)	Herbst	84.89	3.10	85.11	3.43	.731 ns
	TFBC	86.90	2.31	88.18	3.70	.118ns
	P(bet.)	.119 ns		.071 ns		
Midface Length (Co-A) (mm)	Herbst	79.72	7.82	79.18	6.37	.033 *
	TFBC	79.80	5.68	82.08	6.94	.004*
	P(bet.)	.979 ns		.343 ns		
Mandibular length (Co-Gn) (mm)	Herbst	106.13	6.88	108.94	6.33	.000*
	TFBC	106.84	6.87	111.48	10.33	.025*
	P(bet.)	.820 ns		.517 ns		
U1-SN (L1-MP)	Herbst	110.27	7.85	107.66	7.22	.015*
	TFBC	105.65	17.32	103.53	6.03	.667 ns
	P(bet.)	.456 ns		.183 ns		
IMPA (L1-MP)	Herbst	103.20	4.67	102.75	4.15	.690 ns
	TFBC	98.87	6.18	103.63	4.19	.005*
	P(bet.)	.095 ns		.643 ns		
Soft Tissue Convexity	Herbst	120.61	5.96	124.68	5.73	.004*
	TFBC	124.33	4.33	125.59	3.82	.007*
	P(bet.)	.129 ns		.682 ns		
Lower Lip to E-Plane (mm)	Herbst	3.07	1.79	2.34	1.71	.099 ns
	TFBC	3.14	.95	2.18	1.21	.005*
	P (bet.)	.915 ns		.813 ns		
Upper Lip to E-Plane (mm)	Herbst	3.17	1.34	1.05	.74	.000*
	TFBC	2.78	.92	1.57	.66	.011*
	P (bet.)	.459 ns		.114 ns		
Overjet (mm)	Herbst	8.76	2.08	4.56	1.84	.000*
	TFBC	7.71	2.15	2.49	.57	.000*
	P (bet.)	.282 ns		.006*		
Overbite (mm)	Herbst	2.60	1.19	1.70	.47	.028*
	TFBC	2.35	.62	1.89	.51	.159 ns
	P (bet.)	.566 ns		.398 ns		

Significance level p≤0.05, * significant, ns=non-significant, p(bet.) = between groups

Table (2) Comparison of percent change (%) between groups (Mann-Whitney U test):

Percent change (%)	Groups	Mean	Std. Dev	Median	P value
SNA	Herbst group	-.20	2.06	-0.38	1.000 ^{ns}
	TFBC	-.38	1.21	0.187	
SNB	Herbst group	3.14	2.62	2.54	.436 ^{ns}
	TFBC	2.12	1.12	2.17	
ANB	Herbst group	-36.93	16.91	-34.24	.089 ^{ns}
	TFBC	-25.72	18.54	-20.67	
FMA (MP-FH)	Herbst group	4.31	7.37	3.73	.280 ^{ns}
	TFBC	9.83	11.94	7.255	
Facial Angle (FH-NPo)	Herbst group	.27	2.30	0.07	.353 ^{ns}
	TFBC	1.46	2.62	0.636	
Midface Length (Co-A)	Herbst group	-.49	3.10	0.30	.089 ^{ns}
	TFBC	2.83	4.09	1.459	
Mandibular length (Co-Gn)	Herbst group	2.70	1.59	2.52	.912 ^{ns}
	TFBC	4.24	5.04	2.245	
U1-SN (L1-MP)	Herbst group	-2.31	2.51	-2.23	.853 ^{ns}
	TFBC	.12	15.46	-1.058	
IMPA (L1-MP)	Herbst group	-.36	3.43	-0.78	.005 *
	TFBC	5.01	4.46	5.14	
Soft Tissue Convexity	Herbst group	3.43	2.87	2.10	.023 *
	TFBC	1.03	.95	1.058	
Lower Lip to E-Plane (mm)	Herbst group	-.69	83.67	-15.29	.436 ^{ns}
	TFBC	-31.84	27.80	-22.95	
Upper Lip to E-Plane (mm)	Herbst group	-65.94	18.05	-61.91	.052 ^{ns}
	TFBC	-36.44	30.86	-29.65	
Overjet (mm)	Herbst group	-48.46	15.40	-51.26	.011 *
	TFBC	-65.68	11.40	-67.66	
Overbite (mm)	Herbst group	-27.23	26.91	-26.70	.353 ^{ns}
	TFBC	-13.57	31.85	-4.348	

Significance level p≤0.05, * significant, ns=non-significant

Figure 4: pretreatment records of TFBC Group sample.

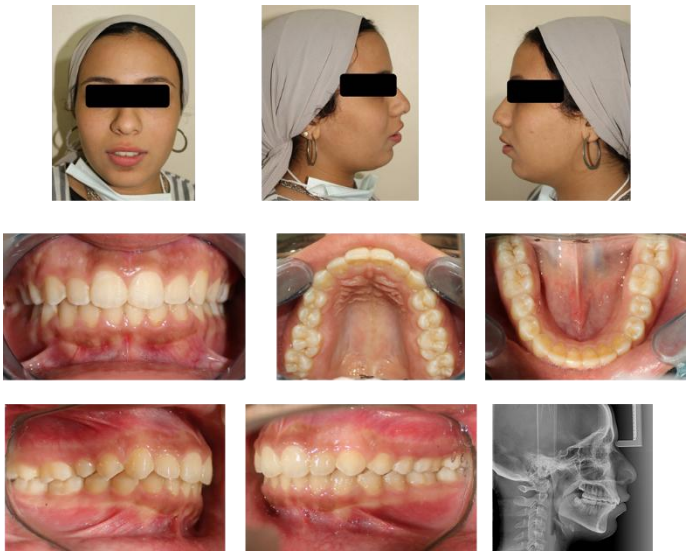


Figure 5: post-treatment records of TFBC Group sample.

Figure 6: pretreatment records of Herbst Group sample.

Figure 7: post-treatment records of Herbst Group sample.

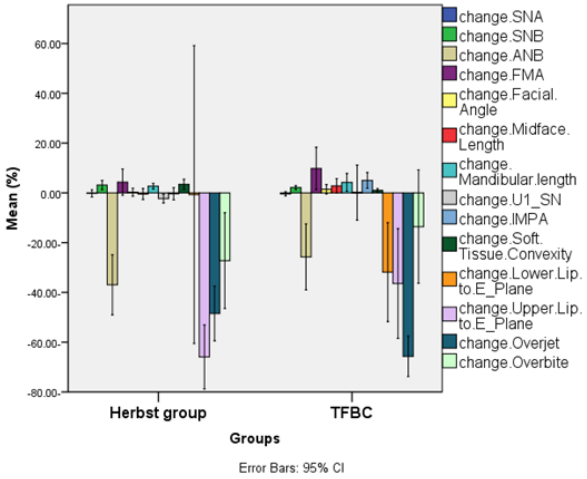


Figure 8: Bar chart illustrating mean value of percent change (%) in both groups.

DISCUSSION

The treatment class II malocclusion due to retrognathism of the mandible in young adult patients is a problematic issue that faces orthodontists because the camouflage treatment through classic extraction mostly results in a bird face that worst the soft tissue profile of the patient, also the second treatment approach; orthognathic surgery is a scary matter for orthodontic patients[8]. So the aim of the current study is to find a simple treatment approach away from orthognathic surgery by using fixed functional appliances to stimulate mandibular growth depending on a condylar growth that results in forward posturing of the mandible to correct the Skeletal Class II anteroposterior discrepancy[27].

It is worth to be mentioned that there is always controversy regarding the skeletal effects of fixed functional appliances through stimulation of condylar growth;many studies have demonstrated successful corrections of skeletal class II in adolescent patients through the use of FFA[28-30].

Although there are different types of fixed functional appliances, there is a controversy regarding these appliances resulting ina proclination of the lower anterior teeth, the cause of the limitation of its skeletal effects[22, 23].In an attempt to overcome this limitation, mini implants have been used with fixed functional appliances that act as a skeletal anchorage to reduce theorthodontic force on lower anterior teeth[21,31,32]. But after using miniscrews, there was little skeletal effect and still more dentoalveolar effects of these appliances [32]. While by using mini plates with Forsus FRD, it revealed more skeletal effects when compared with miniscrews[21,32].

As a result of these successful more skeletal effects achieved by the Forsus appliance combined with miniplates[21,32], we aimed in the present study to compare the dentoskeletal effects of the dentally anchored Twin force bite corrector appliance versus a skeletally anchored Herbst appliance in class II young adult patients that have a little remnant of the condylar growth.

In the present study, a lateral cephalometric radiograph was utilized as a diagnostic method for a comparison between the two groups depending on linear and angular measurements; cephalometric radiographs are widely used in orthodontic practice because of low cost, ease of use, availability, and low radiation exposure. However, there are some demerits of the cephalometric radiograph which limit its use in the field of TMJ evaluation and anatomic superimposition[12, 13].

In the current study, we used two fixed functional appliances different from each other in nature of the anchorage and rigidity due to the following reasons:

-Firstly, as we know that rigid and semi-rigid fixed functional appliances have the same mechanism of action, also their effect in the correction of class II malocclusion is approximately similar to each other (mainly dentoalveolar effect with little skeletal effect) in addition to some of the studies referred to that the acceptance of the patient to the type of fixed functional appliance affect the end result of orthodontic treatment, so in the current study we selected the most type of the dentally anchored fixed functional appliance accepted by the patients regardless its rigidity to obtain final clear results. So we used the twin force bite corrector appliance as a dentally anchored fixed functional appliance in Comparison with the skeletally anchored Herbst appliance.

-Secondly, the Twin force bite corrector appliance is the most commonly used type of fixed functional appliance that can be accepted by patientswithout any complaints related to breakage of the appliance, interfering with speech, or slippage from its attachment. On the hand, the Herbst appliance is a bulky rigid intraoral appliance that is not accepted by the patients and consequently, this will affect the end results of orthodontic treatment because the patients try to remove or break it. So the current study aimed

to evaluate if this bulky rigid appliance (Herbst appliance) produces a significantly greater effect than the semi-rigid, simple one (TFBC) or if the two types have the same effect on the condylar volume and consequently skeletal correction of class 2 malocclusion in young adult patients.

-Thirdly, theTwin force bite corrector and almost many types of the semi-rigid fixed functional appliances have hex nuts at their two ends and were designed to be directly attached to the main rectangular orthodontic archwire and not suitable to be soldered into the surgical mini-plate, so it is very difficult to obtain skeletally anchored TFBC. So in the current study, we use the rigid Herbst appliance because one of its ends is suitable to be soldered to the surgical mini-plate.

As for Comparison between the two groups, pretreatment cephalometric measurements showed a non-statistically significant difference between the Herbst group and TFBC group; this reveals a positive fixed factor for accurate and clear Comparison between the study groups.

Also, post-treatment cephalometric measurements showed a non-statistically significant difference between the Herbst group and TFBC group except for overjet that revealed a statistically significant decrease after treatment with the Herbst group than TFBC group; this was related to the greater skeletal effects of skeletally anchored rigid Herbst appliance which come in concomitant with previous studies[33-35].

As for a Comparison related to the amount of change in cephalometric measurements before and after treatment between the study groups, there was no statistically significant difference between both groups except in IMPA, where the Herbst group recorded a statistically significant decrease than the TFBC group; this was due to the lower incisors have no bracket system that resulted in proclination of them as that occurs with most of dentally anchored semi-rigid fixed functional appliance, this result was similar to that has been reported in previous studies [10, 11, 23, 33].

Again, regarding a comparison of the amount of changes between the two groups, there was a significantly higher percent increase recorded in the Herbst group regarding soft tissue convexity, and a significantly higher percent decrease was recorded in TFBC regarding overjet; this was due to successful improvement in anteroposterior jaw relationship and advancement of the mandible that produced by skeletally anchored Herbst appliance, The horizontal changes that found after treatment by Herbst appliance are in general similar to those reported in previous studies[33-35].

In general skeletal anchorage combined with the Herbst appliance make it able to produce a restraining force on the maxilla and forward force on the mandible that resulted finally in skeletal correction toward a Class I jaw relationship, unlike dentally anchored TFBC appliance that produces a distalization of posterior maxillary teeth and forward force on the lower incisor teeth that lead to proclination of them that limit a skeletal correction of class II malrelationship.

As for the Comparison of pretreatment and post-treatment recorded values within each group, on average, maxillary readings showed no significant difference. On the other hand, mandibular readings were significantly increased after treatment within each of the studied groups as the fixed functional appliance produced restrain force, not retruded force on the maxilla and forward force on the mandible; these results are similar to that of previous studies[12, 33, 34]. For anteroposterior jaw relationship and incisor relationship were significantly corrected after treatment in both groups due to the achieved successful advancement of the mandible,especially with skeletally anchored fixed functional appliances [19-21].

The vertical facial dimension was not affected in the Herbst group. At the same time, it increased in the TFBC group due to the dental anchorage of the TFBC appliance leading to the extrusion of posterior segment and intrusion of the anterior one. In contrast, the skeletal anchorage of the Herbst group has a limited dentoalveolar effect; these results come concomitant with other studies[12, 20, 32]. Also, the lower incisor angulation almost did not change with the Herbst group, while it was significantly increased with the TFBC group; this was due to the forward force produced by the TFBC appliance mainly affect on the angulation of the lower incisor that led to proclination of them while the protrusive force produced by Herbst appliance mainly lead to the advancement of the boy of the mandible[12,20,32].

The soft tissue profile was significantly improved and enhanced in the Herbst group in contrast tothe TFBC group, as most of the class 2 correction in the Herbst groupwas achieved by skeletal movements, as pointed out by previous studies[10,21].

LIMITATIONS AND RECOMMENDATIONS

Large numbers of adult and young adult orthodontic patients have been suffering from periodontal diseases that can interfere with and limit interventional steps of orthodontic treatment and final end results, so we recommend careful assessment of the periodontal health status and oral hygiene measurements before starting the orthodontic treatment for each participant enrolled in future research study especially adult and young adult orthodontic patients.

We recommend performing future research studies on a large sample size of participants of class II young adult orthodontic patients by using skeletally versus dentally anchored fixed functional appliances, also, we recommend for determination of the gender

of participants,males or females before starting future research studies.

CONCLUSION

Regarding the results of the current study, it could be concluded that:

1- The skeletally anchored type IV Herbst appliance and the dentally anchored Twin force bite corrector produce successful correction for class II malocclusion in young adult patients. Still,the Herbst appliance depends on its skeletal effect, which is expressed in great soft tissue profile improvement, while the TFBC appliance depend on its dentoalveolar effects.

2- Skeletal correction of skeletally anchored Herbst appliance reflects great soft tissue profile improvement.

3- Skeletally anchored Herbst appliance has a limited effect on the proclination of lower anterior teeth, which is the main drawback of dentally anchored fixed functional appliances.

FUNDING:

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

DISCLOSURE OF INTEREST:

The authors declare that they have no competing interest.

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