Egyptian
Orthodontic Journal

FOUR YEARS STABILITY EVALUATION OF THE CHANGES OBTAINED BY TWIN FORCE BITE CORRECTOR APPLIANCE

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ABSTRACT:

Introduction: *Class II malocclusion is one of the most frequent problems in orthodontics, as it affects one third of patients seeking orthodontic treatment. Fixed orthopedic appliances as twin force bite corrector (TFBC) and Jasper Jumper (JJ) appliance used for Treatment of Class II, division 1 malocclusion resulting in a mandibular advancement, Long-term stability following orthopedic correction of Class II malocclusion treatment is the fundamental key to a successful treatment outcome.* ***Aim of the work:*** *The objective of this study was to evaluate and compare the post retention stability of skeletal, dental, soft tissue and pharyngeal airway changes obtained with twin force bite corrector and jasper jumper after four years from the end of the treatment.* ***Material and Methods:*** *Two Lateral cephalometric x- rays and two study models was compared for each patient treated with twin force bite corrector and jasper jumper (20 patients) one just after removal of the appliance at the end of treatment and the second one after four years of treatment.* ***Results:*** *All tested perimeters showed non significant difference after 4 years of treatment with TFBC appliance .Only the angular position of the upper incisors relative to FH plane and lower arch depth showed significant difference. Also upper arch depth showed significant*

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difference. The changes obtained by JJ appliances seems to be less stable than TFBC appliance with little non significant difference between both groups. ***Conclusion:*** *Both appliance results in stable skeletal, dental, soft tissue and pharyngeal airway changes with little non significant difference after 4 years of treatment.*

Key Words: *Twin Force Bite Corrector, Jasper Jumper, pharyngeal airway and developing class II division 1 malocclusion.*

INTRDUCTION

Long-term stability following Class II malocclusion treatment is the fundamental key to a successful treatment outcome, and of prime concern for patients and orthodontists. Class II malocclusion is one of the most frequent problems in orthodontics, as it affects one third of patients seeking orthodontic treatment.(1) Class II, division 1 malocclusion, involves maxillary dental and/or skeletal alterations. According to McNamara JR(2) this malocclusion has a higher prevalence of mandibular retrusion in relation to maxillary protrusion. In such cases, the therapy of choice should include the use of facial orthopedic appliances resulting in a mandibular advancement, as long as the patient presents potential for craniofacial growth.(3)

Long-term stability following Class II malocclusion treatment is the fundamental key to a successful treatment outcome, and of prime concern for patients and orthodontists.(4,5) Fixed functional orthopedic appliances are widely used,(6-9) and can be worn in association with multi-bracket therapy, so that Class II malocclusion can be corrected in a single phase treatment.(10) The twin force bite corrector is a recent appliance with ball and socket joint allowing jaws to move freely in all directions and Jasper Jumper appliance considered as one of the most popular flexible devices(11,12) used for correction of class II division 1 malocclusion.

Normally, orthodontic treatment takes a long time and uses complex techniques, usually achieving good results; however, these results may be lost in varying degrees after the removal of appliances and retainers.[13] A major factor contributing to stability is the growth pattern of the patients[14]. A favorable growth pattern, in addition to correct diagnosis, treatment, and retention protocols in motivated patients, probably increases the likelihood of stable long-term treatment results[15]. Orthodontic changes of the position of the first permanent molars have a great tendency to relapse.[16] Besides growth, forces derived from the surrounding oro-facial tissues are believed to promote stability[17]. When dental changes are in harmony with the tongue and facial muscles, the result is thought to be more stable[18].

Good occlusal inter-cuspation following Class II malocclusion treatment has been reported to be necessary to prevent skeletal and dental relapse[18,19]. Nanda suggest good occlusion and cuspal inter-digitations, a constant inter-canine width, and no proclination of the lower incisors as some of the most important factors for long-term stability following orthodontic treatment[18]. Numerous studies and case reports have highlighted the effectiveness of fixed-functional appliances in correcting Class II malocclusion, but long-term analyses of the stability of these results have seldom been reported So the objective of this study was to evaluate and compare the post retention stability of skeletal, dental, soft tissue and pharyngeal airway changes obtained with twin force bite corrector and jasper jumper after four years from the end of the treatment.

MATERIAL AND METHOD

This study was carried out on 20 patients divided into two equal groups (10/each) and exhibiting developing Class II Division 1 malocclusion, indicated for functional appliance therapy and treated with Twin Force Bite Corrector and Jasper Jumper appliances four years ago in the Orthodontic Clinic at Orthodontic Department, Faculty of Dentistry, Tanta University.

-Two series of lateral cephalometric x-rays and study models were made for each patient, one at the end of treatment just after removal of the appliance and a second one after four years to evaluate and compare the stability of skeletal, dental, soft tissue and pharyngeal airway changes produced by the TFBC * and JJ ♠ appliances.

Tracing of the radiographs and landmark identification were performed by the investigator and checked for accuracy after two weeks. Linear and angular measurements were recorded to the nearest 0.5 mm and 0.5 degree, respectively.

Angular Measurements: *(figure 1 and 2)*

1- SNA

2- SNB

3- ANB

4- SN– Pg

5- Facial angle

6- Frankfort horizontal plane to SN plane angle (FH-SN).

7- Upper incisor long axis to Frankfort horizontal plane angle (U1-FH).

8- Lower incisor long axis to mandibular plane angle (L1-MP).

9- Inter-incisal angle.

10- Angle formed by MP and SN.

11- Angle formed by MP and PP.

12- Angle formed by NB line and a line connecting the most anterior point of the upper lip and Pg soft tissue point (H angle).

13- The angle formed by the labial surface of the upper lip at the midline and the inferior border of the nose. (Naso-labial angle).

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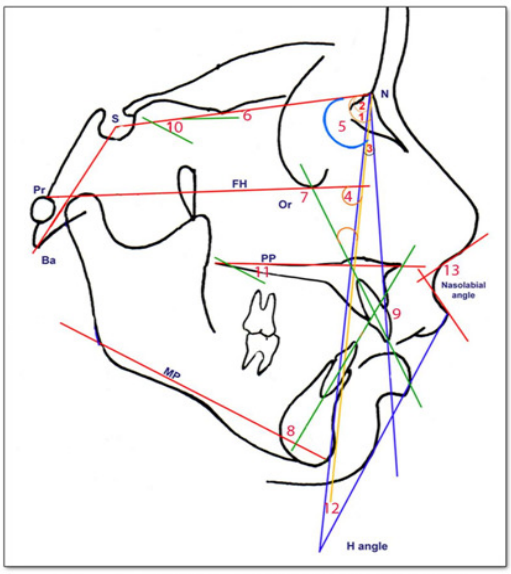

Figure 1 : Cephalometric points, lines, planes and angles.

1- SNA
2- SNB
3- ANB
4- Facial angle
5- SN-Pg
6- FH- SN
7- U1 - FH
8- L1-MP
9- inter-incisal angle
10- MP-SN
11- MP-PP
12- H-angle
13- Nasolabial angle

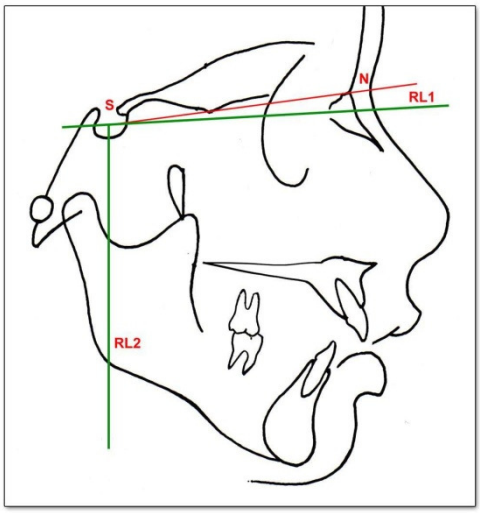

Figure (2): Horizontal and vertical reference planes RL1 and RL2. (Nalbangtil et al 2005) [20]

Linear Measurments: (Figure 3)

1. Upper anterior facial height (UAFH).
2. Lower anterior facial height (LAFH).
3. Total anterior facial height TAFH (N-Me).
4. Posterior facial height (PFH).
5. Overjet.
6. Overbite.
7. The distance from upper incisor tip to reference line RL1 (RL1-U1T).
8. The distance from lower incisor tip to reference line RL1 (RL1-L1T).
9. The distance from upper first molar mesio-buccal cusp tip to reference line RL1 (RL1-U6).
10. The distance from lower first molar mesio-buccal cusp tip to reference line RL1 (RL1-L6).
11. The distance from point A to reference line RL2 (RL2⊥A).
12. The distance from point B to reference line RL2 (RL2⊥ B).
13. The distance from upper incisor tip to reference line RL2 (RL2⊥U1T).
14. The distance from lower incisor tip to reference line RL2 (RL2⊥L1T).
15. The distance from upper first molar distal border to reference line RL2 (RL2⊥U6).
16. The distance from lower first molar distal border to reference line R2 (1RL2⊥L6).
17. The distance from labia superiores to reference line RL2 (RL2⊥ Lab.Sup.).
18. The distance from labia inferiores to reference line RL2 (RL2⊥Lab. Inf.).
19. The distance from Pogonion soft tissue point to reference line RL2 (RL2⊥Pg soft tissue).

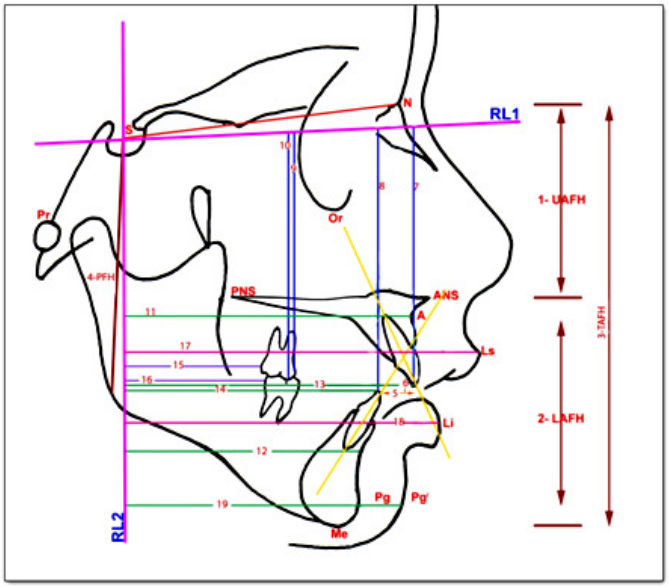

Figure 3 : cephalometric linear measurements.

1- (UAFH).
2- (LAFH).
3- TAFH (N-Me).
4- (PFH).
5- Overjet.
6- Overbite.
7- (RL1-U1T).
8- (RL1-L1T).
9- (RL1-U6).
10- (RL1-L6).
11- (RL2⊥A).
12- (RL2⊥B).
13- (RL2⊥U1T).
14- (RL2⊥L1T).
15- (RL2⊥U6).
16- (1RL2⊥L6).
17- (RL2⊥Lab.Sup.).
18- (RL2⊥Lab. Inf.).
19- (RL2⊥Pg soft tissue.).

Airway Measurements *(Figure4)*

The pharyngeal airway space was measured at three levels; upper, middle and lower. First a reference line perpendicular to RL1 plane was drawn .Upper Pharyngeal Air-Way Space(UPAS) is the distance from PSP which is the PNS part of the soft palate to the posterior pharyngeal wall perpendicular to the reference line and the Middle Pharyngeal Air-Way Space (MPAS) is the distance from ESP which is the end of the soft palate to the posterior pharyngeal wall perpendicular to the reference line while, the Lower Pharyngeal Air-Way Space (LPAS) the distance between anterior and posterior pharyngeal wall perpendicular to the reference line at the level of the superior margin of the body of the hyoid bone (HB).

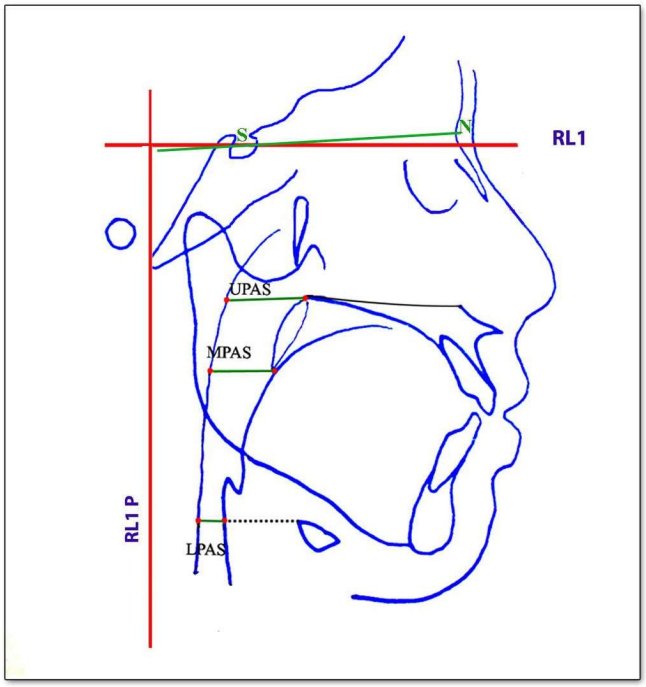

Figure (4): upper, middle and lower pharyngeal airway space (UPAS, MPAS and LPAS).

Dental Cast Analysis *(Figure5)*

Inter-molar and inter-canine widths were measured to quantify the changes in the anterior and posterior arch width of maxilla and mandible. Arch circumference and arch depth were also measured before insertion and after removal of the appliance and the obtained data were statistically analyzed. The maxillary and mandibular arch depth (AD), inter-canine width (ICW), inter-molar width (IMW) and arch circumference (AC) were measured using calipers• accurate to 0.1 mm.

Arch depth (AD) was measured from the midpoint of the most labial aspect of the central incisors to the point bisecting the line connecting the mesial contacts of the first molars .Inter-canine width (ICW) was

• Digital dental caliper. Masel orthodontics. MASEL 1822 Aston Avenue Carlsbad, CA 92008 USA Ph: +(1) 800 0986 2735 Fax: +(1) 800 0996 2735

measured between the cusp tips or estimated cusp tips when wear facets were present. Inter-molar width (IMW) was measured between the buccal fissures on the occlusal surfaces of both lower first molars (Yasuko Kuroda et al 2010).[21]

For all the study model parameters two measurements were taken for each parameter and averaged.

Arch circumference (AC): the sum of the distances measured from the mesial aspect of the right first permanent molar to the distal aspect of the right permanent lateral incisor, distal aspect of the right permanent lateral incisor to midline, midline to distal aspect of the left permanent lateral incisor and distal aspect of the left permanent lateral incisor to mesial aspect of the left first permanent molar (Osborn et al 1991).[22]

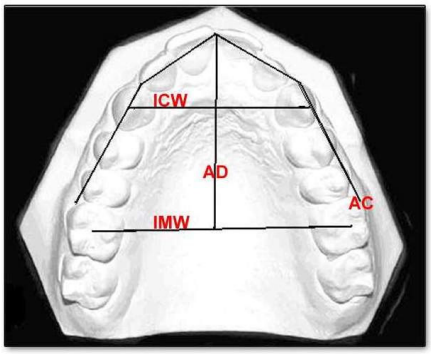

Figure (5 A)

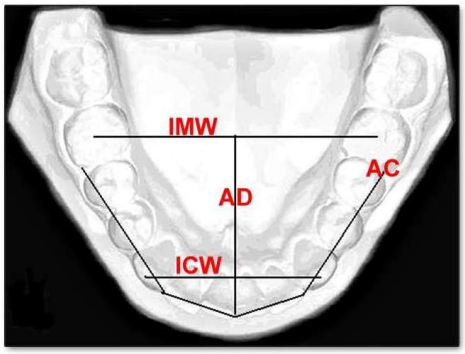

Figure (5 B)

Figure (5 A, B): Upper and lower models: inter-canine width (ICW), inter-molar width (IMW), arch depth (AD) and arch circumference (AC).

In order to reduce the method error, all measurements were performed twice with an interval of at least two weeks between the registrations. The mean value of the duplicate registrations was used in the final evaluation. For each variable, the mean, the slandered deviation was calculated. A student's t test for paired sample was used to assess the significance of skeletal, dental, soft tissue and pharyngeal airway changes produced by each appliance. For group comparisons, the student t test for

unpaired sample was utilized. The statistical significance was determined at the probability levels of P. ≤ 0.05. All statistical calculations were carried out with SPSS 17.0* software.

RESULTS

All skeletal and dental changes obtained by both appliances are stable after four years with non significant difference but the stability of skeletal changes of twin force bite corrector is better than jasper jumper appliance which shows greater but still non significant skeletal changes. ANB increased by 0.3 degree and 1.9 degree for both appliances respectively and little non significant changes occurred in anterior and posterior facial height ,also facial angle and mandibular plane angle are stable after four years of treatment for both appliances.

A significant difference was found regarding **U1 to FH°** which increased by 5.7 degree and 7.05 degree for TFBC and JJ respectively. While L1 to Mp and inter-incisor angle showed non significant changes in both appliances. Also the soft tissue H angle , naso-labial angle , upper, middle and lower pharyngeal airway changes obtained by both appliances are stable with non significant differences for TFBC after four years compared with greater but still non significant changes for JJ appliances.

A significant increase was found regarding upper arch depth after four years of treatment with TFBC when compared with JJ appliance (1.95 mm and 3.6 mm) respectively. (P. value ≤ 0.05) and a highly significant increase was found regarding lower arch depth after four years of treatment with TFBC when compared with JJ appliance (2 mm and 3.2 mm) respectively. (P. value < 0.001). On the other hand upper and lower inter-canine and inter-molar width shows little non significant changes for both appliances.

*Statistical Package For Scientific Studies

Table (1). Comparison of Stability of antro-posterior and vertical skeletal changes obtained with TFBC and JJ after 4 years

Parameters	Post-TFBC		4 years After TFBC		Difference TFBC after 4 years	Difference jj after 4 years	t	p
	Mean	SD	Mean	SD				
SNA°	82	2.47	82.5	2.58	0.5	0.7	0.442	0.663
SNB°	77.9	2.36	77.7	2.11	0.2-	-0.3	٠.201	0.844
ANB°	4.1	.94	4.4	.68	0.3	1.9	0.392	0.704
RL2⊥Amm	67	2.89	68.20	2.16	1.2	2.0	1.052	0.307
RL2⊥B mm	59.40	3.09	59	2.87	- 0.4	-1	0.304	0.768
facial angle°	84.7	3.29	84.4	3.02	- 0.3	-0.6	0.209	0.384
SN to Pg°	76.9	1.87	76.45	1.36	- 0.45	-0.8	0.617	0.546
FH to SN°	7.65	1.68	7.2	1.61	- 0.45	-0.65	0.613	0.548
MP to PP°	30.45	6.13	31.1	4.36	0.65	0.65	0.269	0.788
MP to SN°	37.55	3.16	38	2.58	0.45	0.1	0.354	0.731
UAFH mm	57.10	4.43	57.84	3.14	0.74	0.8	0.432	0.672
LAFH mm	67.20	4.51	67.8	3.51	0.6	0.4	0.438	0.663
TAFH mm	124.30	7.76	125.84	5.44	1.54	1.2	0.508	0.614
PFH mm	75.90	5.3	75.54	2.65	- 0.36	-0.6	0.189	0.849

P. value ≤ 0.05* (significant)

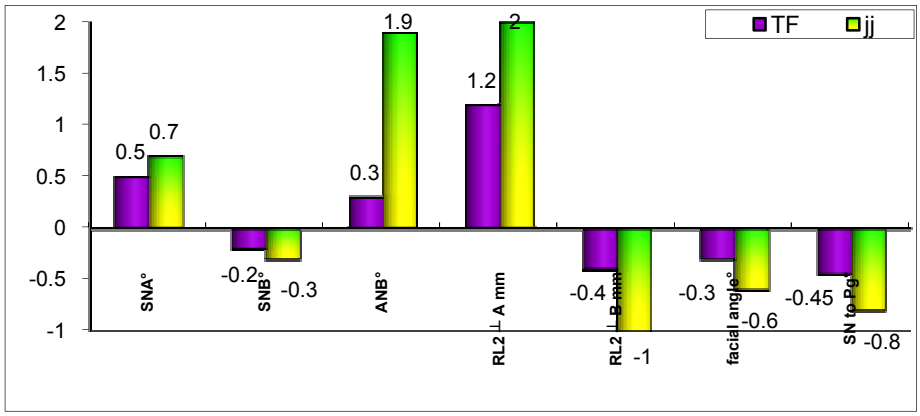

Fig (6 A): Comparison of Stability of antero-posterior skeletal changes obtained with TFBC and JJ after 4 year

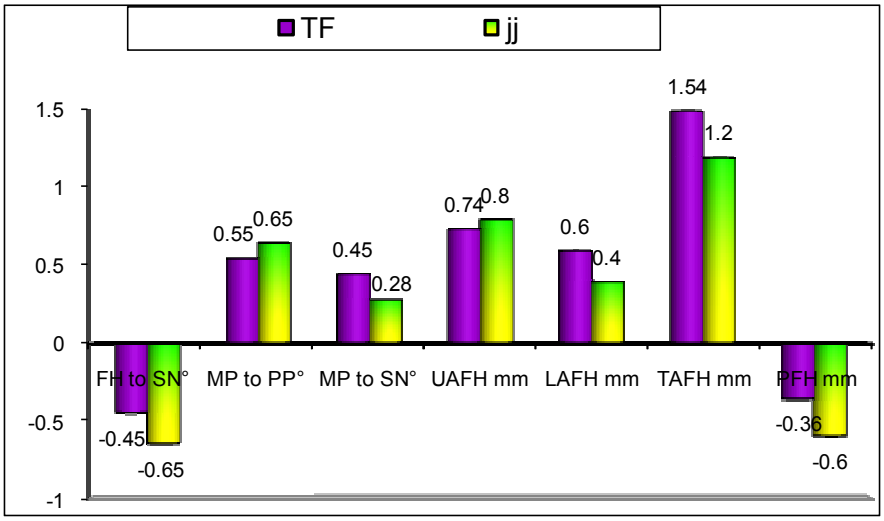

Fig (6 B): Comparison of Stability of vertical skeletal changes obtained with TFBC and JJ after 4 year

Table (2): Comparison of Stability of antero-posterior and vertical dental changes obtained with TFBC and JJ after 4 years

Parameters	Post- TFBC		4 years After TFBC		Difference TFBC after 4 years	Difference jj after 4 years	t	p
	Mean	SD	Mean	SD				
Overjet	1.5	1.43	2.1	1.11	0.6	1.6	1.052	0.308
RL2⊥U1T mm	70.70	2.78	71.7	1.92	1	1.3	0.939	0.362
RL2⊥L1T mm	70.9	3.05	70.6	2.57	-0.3	-0.6	0.242	0.815
RL2⊥U6 mm	27	1.36	29	1.25	2	3.0	3.424	0.003
RL2⊥L6 mm	32.90	2.64	32.10	2.15	-0.8	- 1.1	0.742	0.467
Overbite mm	0.80	.75	2.1	.96	1.3	1.35	3.374	0.003
RL1⊥U1T mm	77.40	3.53	78.60	2.28	1.2	1.6	0.904	0.378
RL1⊥L1T mm	73.4	4.69	73	3.54	0.4-	- 0.9	0.224	0.832
RL1⊥U6 mm	67.60	4.12	68.80	3.41	1.2	2	0.712	0.487
RL1⊥L6 mm	67.60	4.49	68	3.68	0.4	0.64	0.219	0.829

P. value ≤ 0.05* (significant)

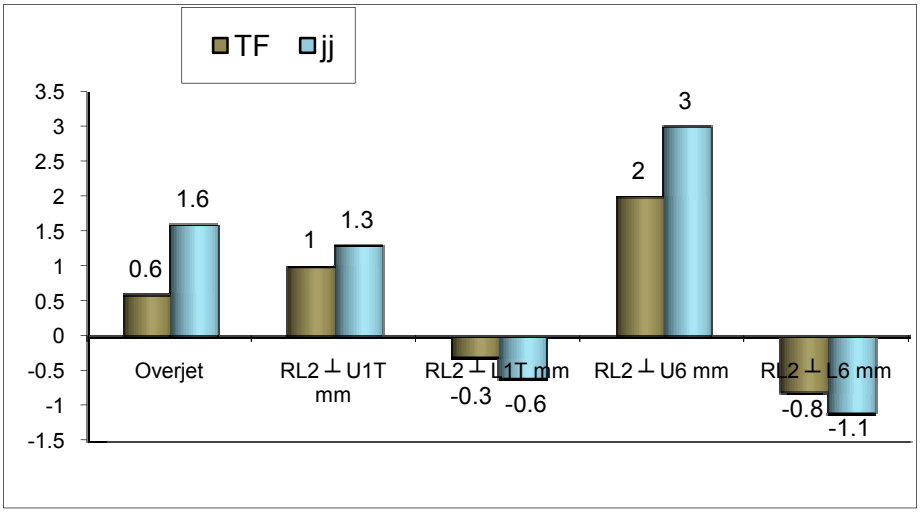

Fig (7A): Comparison of Stability of antero-posterior dental changes obtained with TFBC and JJ after 4 year.

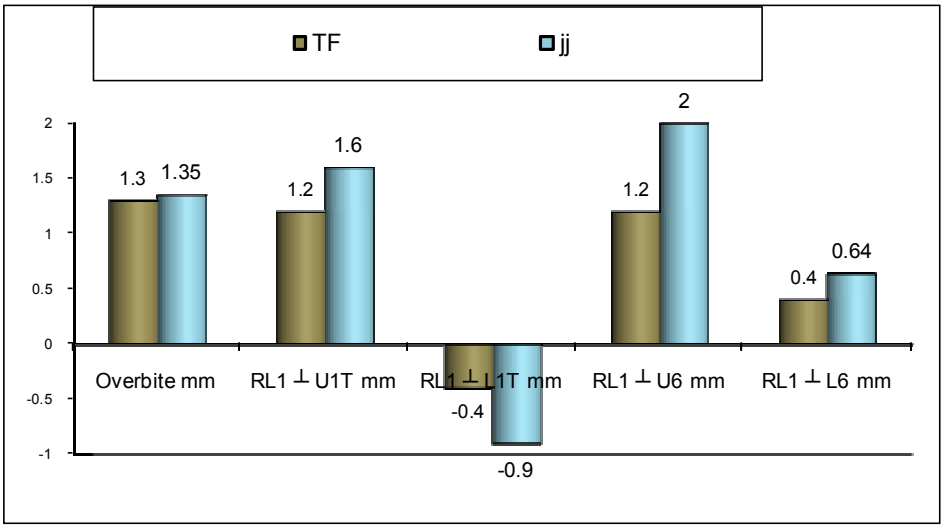

Fig (7B): Comparison of Stability of vertical dental changes obtained with TFBC and JJ after 4 year.

Table(3): Comparison of Stability of angular changes of the incisors obtained with TFBC and JJ after 4 years

Parameters	Post-Twin Force		After 4 years		Difference TFBC after 4 years	Difference jj after 4 years	t. test	P Value
	Mean	SD	Mean	SD				
U1 to FH°	108.40	3.74	114.1	2.14	5.7	7.05	5.704	0.001**
L1 to MP°	105.80	4.70	102.30	3.62	- 3.5	- 4.8	1.869	0.078
U1 to L1°	121.75	5.42	121	3.54	-0.75	- 1.25	0.373	0.718

P. value < 0.05* (significant)

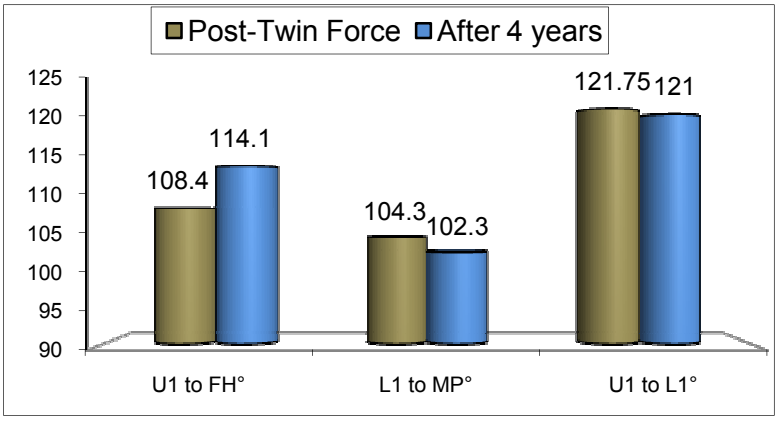

Fig (8 A): Comparison of Stability of angular changes of the incisors obtained with TFBC after 4 years

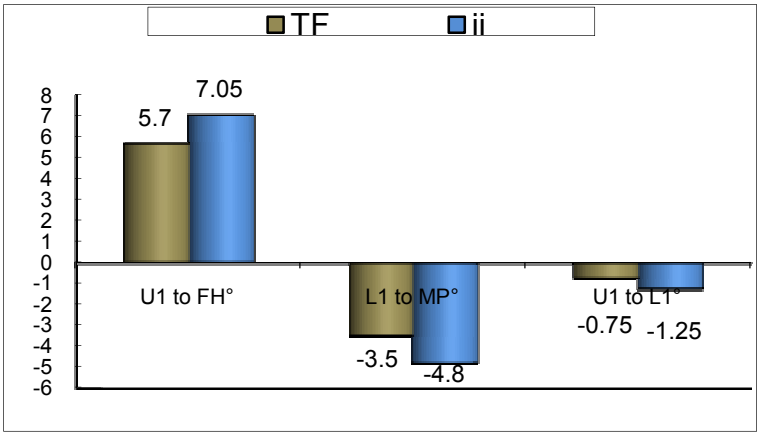

Fig (8 B): Comparison of Stability of angular changes of the incisors obtained with TFBC and JJ after 4 years

Table (4): Comparison of Stability of soft tissue changes obtained with TFBC and JJ after 4 years

Parameters	Post-Twin Force		After 4 years		Difference TFBC after 4 years	Difference jj after 4 years	t. test	P Value
	Mean	SD	Mean	SD				
RL2⊥Lab.Superior mm	83.40	4.08	85	3.25	1.6	3.0	0.968	0.345
RL2 ⊥Lab. Inferior mm	87.85	5.65	87	4.75	- 0.85	- 1.91	0.364	0.719
RL2⊥Pg Soft Tissue mm	73.30	7.62	72.6	6.91	- 0.7	- 1.60	0.218	0.832
H Angle°	16.40	3.23	17	2.47	0.6	0.9	0.474	0.646
Nasolabial Angle°	112	8.41	109	8.65	- 3	- 6.0	0.793	0.442
UPAS mm	15.74	4.66	16	3.84	0.26	0	0.144	0.893
MPAS mm	13.49	1.82	13.51	1.25	0.02	0	0.033	0.977
LPAS mm	12	3.14	11.5	3.10	-0.5	- 1.0	0.359	0.724

P. value < 0.05* (significant)

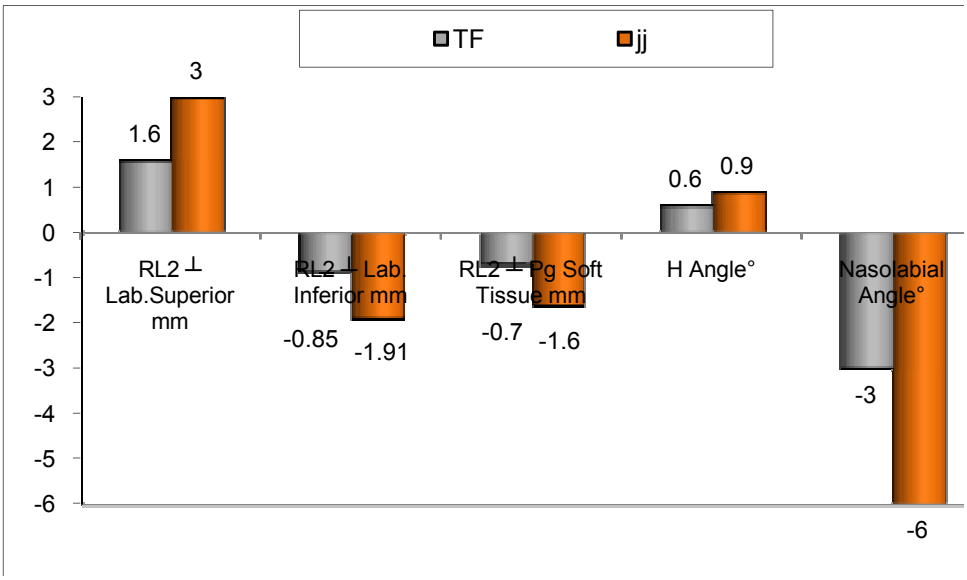

Fig (9 A): Comparison of Stability of soft tissue changes obtained with TFBC and JJ after 4 year

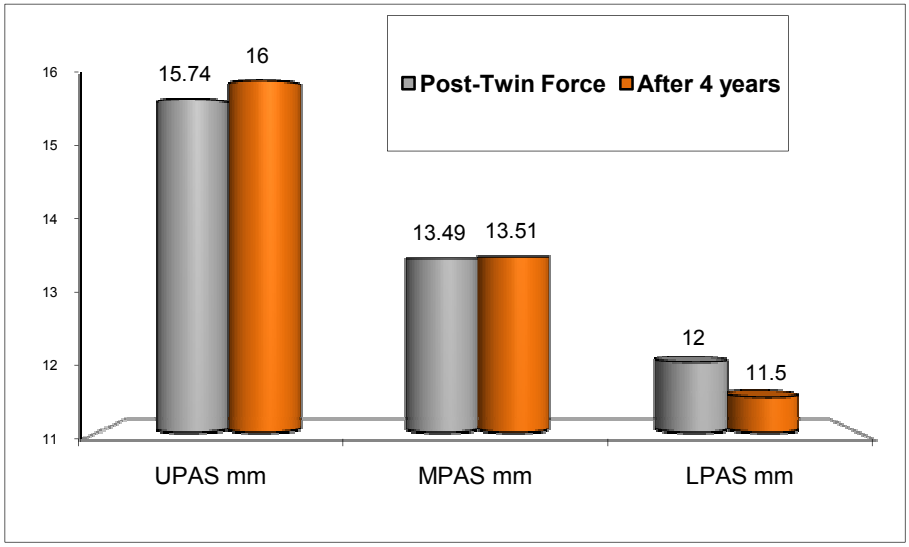

Fig (9 B): Comparison of Stability of pharyngeal airway changes obtained with TFBC after 4 year

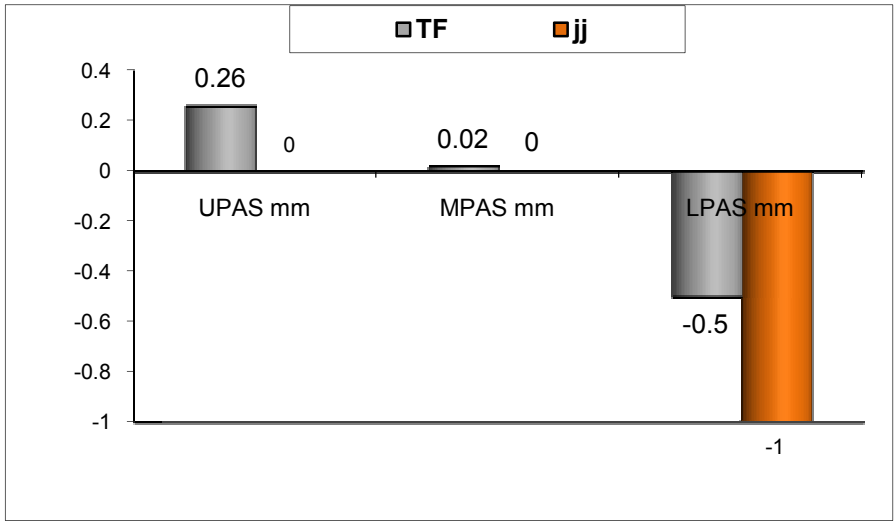

Fig (9C): Comparison of Stability of pharyngeal airway changes obtained with TFBC and JJ after 4 year

Table (5). Comparison of Dental model changes obtained with TFBC and JJ after 4 years

Parameters	post-Twin Force		After 4 years		Difference TFBA after 4 years	Difference jj after 4 years	t. test	P Value
	X	SD	X	SD				
Upper inter-canine width	35	2.60	35.75	2.01	0.75	0.1	0.719	0.479
Upper inter-molar width	47	2.3	48.3	2.96	1.3	1.20	1.103	0.287
Upper arch depth	28.05	1.64	30	1.87	1.95	3.60	2.484	0.023*
Upper arch circumference	76.25	3.69	77.35	2.85	1.1	1.35	0.748	0.465
lower inter-canine width	28.4	1.22	29.2	1.42	0.8	1.1	1.349	0.193
lower inter-molar width	43	2.30	44	2.04	1.0	0.95	1.029	0.317
Lower arch depth	21	1.22	23	1.12	2.0	3.2	3.824	0.001**
Lower arch circumference	65.4	5.19	67	3.54	1.6	1.4	0.809	0.431

P. value < 0.05* (significant)

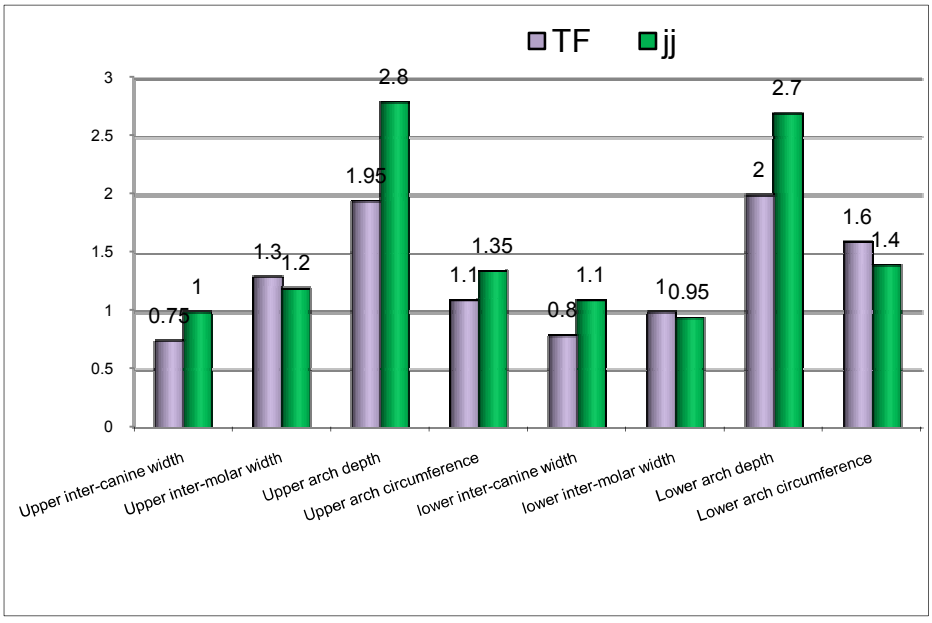

Figure (10). Comparison of Dental model changes obtained with TFBC and JJ after 4 years

DISCUSSION

Twin Force Bite Corrector (TFBC) considered a new fixed inter-maxillary appliance with a built-in constant force for Class II correction. The age group of the selected sample ranged from 13 years to 16 years as they treated by functional appliances four years ago this came in accordance with many authors[23-28] as they stated that, the important key in Class II appliance therapy is the treatment timing and for optimal results, functional appliances should be utilized during or just after the peak growth period. Also Pancherz and Hagg[28,29] and other au thors [26, 3, 31-33] have shown that skeletal improvement with the Herbst appliance was related to somatic maturation.

In the present study both TFBC and JJ group was treated by non extraction protocol and result in good and stable results after four years from the end of treatment this came in accordance with Paquette DE et al[34], Uhde MD et al[35], Fidler BC et al[5], Artun J, et al[36], Elms TN et al[37], Birkeland K et al .[38] and Leonardo T C et al[39].

A slight non significant increase in overjet and overbite and slight proclination of lower incisors was found, this came in accordance with Ashok Karad et al[40]. Also our result agreed with Hansen K et al[41] who studied the stability of the Herbst appliance. In the present study there were a non significant difference between TFBC and JJ regarding antero-posterior and vertical skeletal changes but in JJ group ANB angle increased by 1.9 degree while in TFBC group increased by 0.3 degree, point A become more forward and point PG become more backward in JJ group than TFBC group. This came in accordance with Aditya Chhibber et al[42] who found stable post-treatment occlusions with the twin force bite corrector two to seven years after treatment.

A similar result to the present study was obtained by Hansen K et al[43], Harres EF[44], Tibana RH et al[45] and Tesiopas N et al [46], all stated that the changes was negligible and related to normal growth. Also the findings of the present study agreed with Giorgio Cacciatore et al[47] for Forsus appliance after the end of treatment by 2 years . A similar result was obtained by Darwin Vaz et al[48].

In the present study overjet increased by 1.6 mm in JJ and 0.6 mm in TFBC but still non significant difference, also upper incisor tip become more forward in JJ group than TFBC group, this came in accordance with Madone and Ingervall[49] as they reported partial relapse of the molar relationships. Also Uhde and colleagues[35] and Hellekant and colleagues[50] have also reported minor relapse of molar relationships and overjet in treated cases.

All dental measurements shows non significant changes after four years these findings came in accordance with previous studies for the MARA appliance as Siara-Olds et al.[51] and Ghislanzoni et al.[52]. In the present study the over bite increased by 1.3 mm this results agreed with Simons ME et al[53] Little RM et al[54] and Uhde MD et al[35].

Regarding the angular position of the upper and lower incisors relative to each other's and to FH and MP planes a highly significant difference was found in the position of the upper incisors relative to FH plane in TFBC group after 4 years of treatment as it increased 5.7 degrees these results came in accordance with Magnhild Lerstøl et al[55] for combined activator-headgear treatment.

All soft tissue changes shows non significant changes after 4 years but labia superiors moved forward and labia inferiors moves backward in JJ group greater than TFBC group, the mandibular incisors were proclined during treatment and demonstrated similar trend in post-treatment period as well this came in accordance with the findings of Paquette DE et al[36], Elms T et al 1996[37], Schulhof et al[56] and Shields TE et al (57).

The widening effect of both TFBC and JJ appliances on upper, middle and lower pharyngeal airway remain stable after 4 years with little decrease in LPAW by 0.5 mm in TFBC group and 1 mm in JJ group which considered insignificant changes these result came in accordance with Hänggi MP et al[58] for activator-headgear and fixed appliance treatment.

In the present study a highly significant difference regarding the lower arch depth and a significant difference regarding upper arch depth after four years of treatment with TFBC appliance these finding agreed

with Hans Pancherz et al[59] and Moyers RE[60] as they reported that the mandibular inter-molar arch width normally increases with age.

In contrast to the result of the present study Harris[44] and Tsiopas et al[46] reported marked decrease in the mandibular inter-canine arch widths this may be due to the difference in the period of study. Also in contrast to the results of the present study Glenn G et al[61] and Thilander B[13] found that Maxillary arch length was decreased during treatment, due to up righting and retraction of incisors. The mandibular arch length was maintained during the course of treatment. However, the arch lengths decreased in the post-retention stage. This also supports the concept of decrease in arch length consequent to the anterior component of force that tends to cause a mesial drift of the posterior teeth with time and the increase of the arch length of the present study due to slight proclination of upper and lower incisors and slight backward movement of the lower molars in the post-retention stage.

CONCLUSIONS

All skeletal, dental, soft tissue and pharyngeal airway changes obtained by both appliances are stable after four years with non significant difference while ANB angle, upper and lower arch depth shows less stable with significant increase after four years of treatment. The stability of TFBC is better than JJ appliance. Both appliances are effective for treatment of developing Class II division 1 malocclusion.

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