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A comparison of the effects of twin block and herbst appliances in the treatment of skeletal class II malocclusions - A Cephalometric Study

[1]Shoukathali P.H, Department Orthodontics and Dentofacial Orthopaedics, PG Student Royal Dental College, Kerala University of Health Sciences, Kerala, India.

[2]Varsha Vijayan, MDS, Department Orthodontics and Dentofacial Orthopaedics, Private Practitioner Royal Dental College, Kerala University of Health Sciences, Kerala, India.

[3]Hanna Varghrse, MDS, Department Orthodontics and Dentofacial Orthopaedics, Private Practitioner Royal Dental College, Kerala University of Health Sciences, Kerala, India

[4]Vaisakh, Department Orthodontics and Dentofacial Orthopaedics, Reader, Royal Dental College, Kerala University of Health Sciences, Kerala, India.

[5]Hariprasad A, Department Orthodontics and Dentofacial Orthopaedics, Assistant Professor, Royal Dental College, Kerala University of Health Sciences, Kerala, India

[6]Terence Abraham, Department Orthodontics and Dentofacial Orthopaedics, Reader, Royal Dental College, Kerala University of Health Sciences, Kerala, India

Corresponding Author: Shoukathali P.H, Department Orthodontics and Dentofacial Orthopaedics, PG Student Royal Dental College, Kerala University of Health sciences, Kerala, India.

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Abstract

Objective: To evaluate the effects of the Twin Block appliance and Herbst appliance on skeletal, dental and soft tissue parameters in skeletal Class II malocclusion.

Methods: Standardised pre and post lateral cephalograms of 24 patients (12 each) who had undergone treatment for class II malocclusion with the Twin Block appliance and Herbst appliance were selected. Skeletal, dental and soft tissue parameters were determined. 31 parameters (22 linear and 9 angular measurements) were considered in the study.

Results: The mean mandibular length in the Twin Block group demonstrated an increase when compared to the Herbst group. Total anterior facial height, lower anterior facial height and posterior facial height increased more with the Twin block appliance, when compared to the Herbst appliance. The inclination of the upper incisors decreased more with the Twin block appliance when

compared to the Herbst appliance and the inclination of the lower incisors increased more with the Herbst appliance. The upper molars moved more backward with the Herbst appliance. Facial convexity and the depth of mentolabial fold increased more with the Twin block appliance. Forward movement of the lower lip occurred more with the Herbst appliance, whereas a backward movement of the upper lip occurred more with the Twin block appliance. Upper and lower pharyngeal width increased more with the Twin block.

Implications and conclusions: An increase in the mandibular length was the primary objective of the treatment in the present study. The Twin block appliance demonstrated a better result than the Herbst appliance, as long as mandibular length was concerned which was statically significant. While more of skeletal changes where obtained in the Twin block appliance, a combination of skeletal and dental changes were obtained with the Herbst appliance.

Keywords: Herbst appliance, Twin block appliance, class II skeletal pattern.

Introduction

Class II malocclusion is one of the most common orthodontic problems and occurs in about one-third of the population. It occurs due to a sagittal skeletal discrepancy between the maxillary and mandibular arch, characterised by a deficient or posteriorly positioned mandible and/or a prognathic or anteriorly positioned maxilla. According to McNamara, 75% of the class II skeletal discrepancies occur due to mandibular retrognathism.[1] The average prevalence of Class II malocclusion was found to be 20.2%.[2] In the USA, the prevalence was found to be 34% in whites and 18% in blacks. [3] However, the prevalence is 31% in Danish children and it was as low as, 11% in Kenya and 16.4 % in Saudi Arabia. While the prevalence is 4.9% in South India and 14.6 % in North India, The aetiology of Class II malocclusion is multifactorial in nature.[4]Studies on human inheritance and their role in class II malocclusion support the belief that hereditary factors affect the growth and size of the mandible. Stein et al. found that there was a high correlation of class II malocclusion between siblings.[5]Lundström reported that in monozygotic twins, there was a 68% concordance of having a Class II malocclusion; on the other hand, dizygotic twins had a 24% concordance, suggesting a polygenetic mode of inheritance.[6] Environmental factors such as habits, mode of respiration, resting tongue posture, trauma, and abnormal oral muscle activity also play an important role in the development of certain types of malocclusion.[7] As an example, the early loss of maxillary second deciduous molars in a patient with an otherwise Class I occlusion could result in the mesial migration, rotation and tipping of the maxillary first molars, and the creation of a Class II malocclusion. Throughout the years, many functional appliances have been developed, but Norman W. Kingsley, in 1877, was the first to introduce an appliance designed to stimulate sagittal mandibular growth.[8]The appliances gained popularity in the 1930s with Anderson's activator. The basic idea behind these appliances is to force the lower jaw forward to stimulate mandibular growth.[9,10] The Herbst appliance, was originally designed by Emil Herbst in 1905 and was modified and reintroduced by Hans Panchertz in 1970.[11,12] It is a fixed bite-jumping device for the treatment of skeletal Class II malocclusions. The Twin Block appliance was developed by William Clark in 1977.[13]

Materials and Method

The cephalograms that are used in this study are taken from pre-existing records of patients treated in the Department of Orthodontics and Dentofacial

Orthopedics, Royal Dental College. Standardized pre-treatment and post-treatment lateral cephalograms of 24 patients between the ages of 10-18 yrs.

The inclusion and exclusion criteria are presented in Table No: 1.

Table 1: Inclusion and Exclusion criteria used in present study.

Inclusion Criteria
• Skeletal Class II relationship
• Mandibular retrognathism (SNB < 78°)
• Bilateral Class II molar and canine relation
• Patient in fourth or fifth stage epiphyseal radiograph stage on hand wrist
• Over jet ≥ 5 mm
• epiphyseal stages on hand wrist radiographs, as defined by Bjork (1972)
• Minimal crowding in dental arches (≤4mm)

Exclusion criteria
• No history of orthodontic treatment either prior to or during functional appliance therapy
• Congenitally missing or extracted permanent tooth (except third molars)
• Severe facial asymmetry determined by clinical or radiographical examination
• Systemic diseases that may affect the orthodontic treatment results

The sample size was calculated using the software G* power 3.1.9.4.The total sample size was calculated, which was 24, which is 12 for each group.A α error probability of 0.05 and power (1-β error probability) is 0.8.

Comparative study design

The cephalostat used was GXDP - 700™ Digital Panoramic X-ray System **(Gendex Dental System)** to record lateral cephalograms. Standardised pre and post lateral cephalograms of 12 patients each, who underwent treatment for Class II malocclusion with Twin block and Herbst appliances (fig1 & 2) were selected for the study. Skeletal, dental and soft tissue parameters were determined. 31 parameters (22 linear and 9angular measurements) were measured on standardized lateral cephalometric radiographs. Data was analyzed statistically using Mann Whitneys test to determine the difference between the baseline and post treatment values.

The outcome measurements are presented in Table 2

Figure 1: Twin block appliance

Figure 2: Herbst appliance

Table 2: Outcome Measurements

	Vertical Measurements	Dental Changes	Soft Tissue Changes
Linear	1. LAFH 2. Effective mandibular length(Co-Gn) 3. Ramus height(Ar-Go) 4. Total anterior facial height (N-Me) 5. Lower posterior face height(S-Go)	1. UI-NA 2. LI-NB 3. PTV-U6 4. PTV-L6 5. PTV-Li 6. PTV-Ui	1. STPog-S vertical 2. Li- S vertical 3. Ls- S vertical 4. Ls-E line 5. Li-E line
Angular	1. SNA 2. SNB 3. Gonial angle(Ar-Go-Gn)	1. UI-NA 2. Li-NB 3. Li-MP	1. FH- N´-Pog 2. Mentolabial angle 3. H angle
Antero-Posterior	1.N per-Pog 2.PTV-Pog 3.PTV-PointB 4.PTV-PointA 5.Corpus length(Go-Gn) 6.(Co/OLp)condylar length		

Result

Almost all cephalometric variables indicated that the Twin block appliance has no restraining effects on the maxilla while a few variables demonstrated a restraining effect of maxillary growth with the Herbst appliance this was statistically significant (Table: 3 & 4) & (Graph no: 1 & 2). A forward growth of the mandible occurred with both the appliance (Table: 3, 4 & 5)& (Graph no: 1, 2, 4&5),while few variables (SNB, Go to Gn, N per to Pog and PTV to Pog) demonstrate a forward growth of the mandible was more with the Twin block appliance this was statistically significant (Table: 3 & 4).

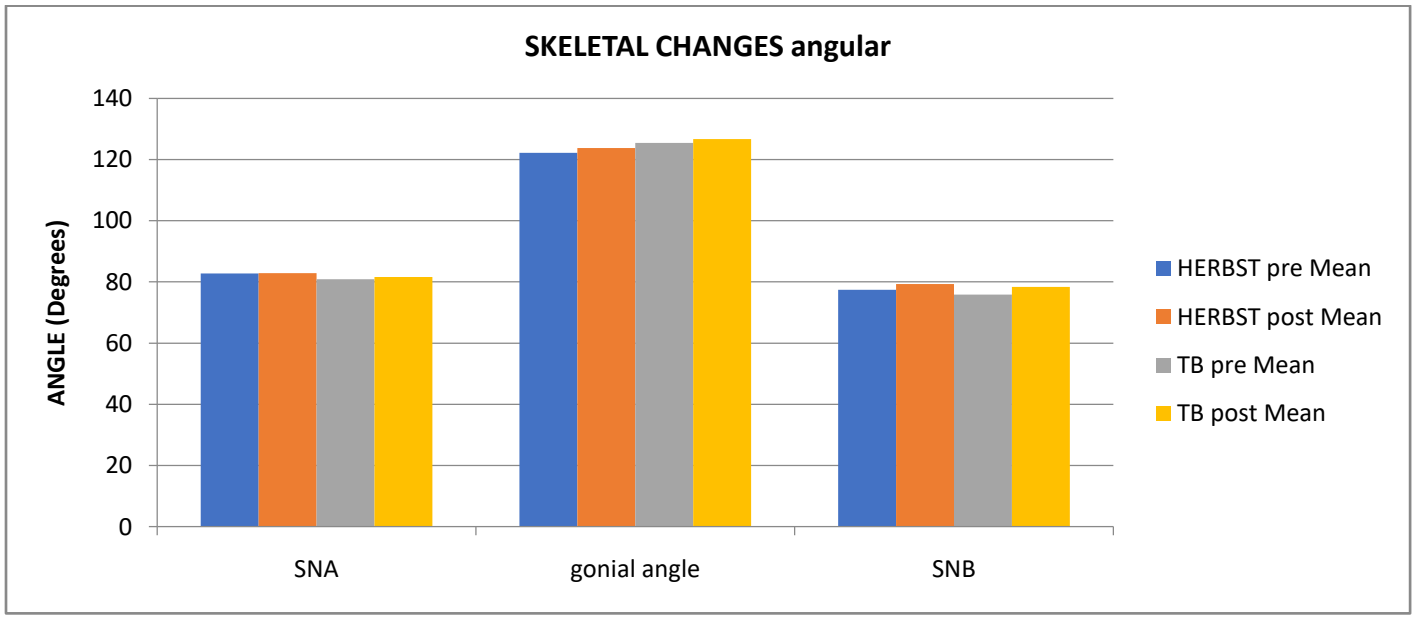
All cephalometric variables indicated that the Twin block appliance and Herbst appliance improved the class II skeletal relationship shown in Table: 3&6&Graph no: 1&4. All facial heights were increased with both the appliance, more with the Twin block appliances. This was statistically significant (Table: 4).The gonial angle increased with both the appliance (Ar-Go-Gn) (Table: 4) & (Graph no: 2). The sagittal position of Condylar head(Co/OLp) increased with both the appliance, more with the Twin block appliances this was statistically significant (Table: 4).The Ramus height was an increased with both appliances(Ar-Go), but was greater with the Twin block appliance this was statistically significant (Table: 4) & (Graph no: 2).

The retraction of maxillary incisors occurred with both the appliances (UI-NA), but was more with Twin block appliance this was statistically significant (Table: 5) & (Graph no: 3). The proclination of the mandibular incisor occurred in both appliance (Li- NB, PTV to Li, Li-MP), but was more with the Herbst appliances this was statistically significant (Table: 5) & (Graph no: 3). Indicates that Over jet decreased with both the appliances. The distalization of the maxillary molars occurred with both the appliances (PTV to U6), but was

more with the Herst appliance this was statistically significant (Table: 5) & (Graph no: 3).The mesialization of the lower molars occurred with both the appliances (PTV to L6). Retraction of the maxillary incisors (PTV to U1) occurred with both the appliances, but was more with the Twin block appliance this was statistically significant (Table: 5) & (Graph no: 3). Mentolabial fold became less pronounced with the both the appliances, more with Twin block appliance (P=0.005). The H angle decreased with both appliance, but was more with the Twin block appliance (P=<0.04). This indicates Upper lip prominence decreased more with the Twin block appliance. Forward movement of the lower lip occurred with both appliance (Li to S vertical, Li to E line) but was more with the Twin block appliances this was statistically significant (Table: 6) & (Graph no: 4).A backward movement of the upper lip occurred with both appliances (Ls to S vertical) (Ls to E line) (Table: 6) & (Graph no: 4).

	HERBST				TB				
Measurements	Pre		post		Pre		post		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Skeletal Changes									
SNA	82.75	1.76	82.92	1.78	80.83	1.59	81.58	1.51	0.005
SNB	77.42	1.88	79.33	1.97	75.83	1.85	78.33	1.87	0.03
Gonial angle	122.17	7.63	123.75	7.98	125.42	9.57	126.67	9.59	0.34

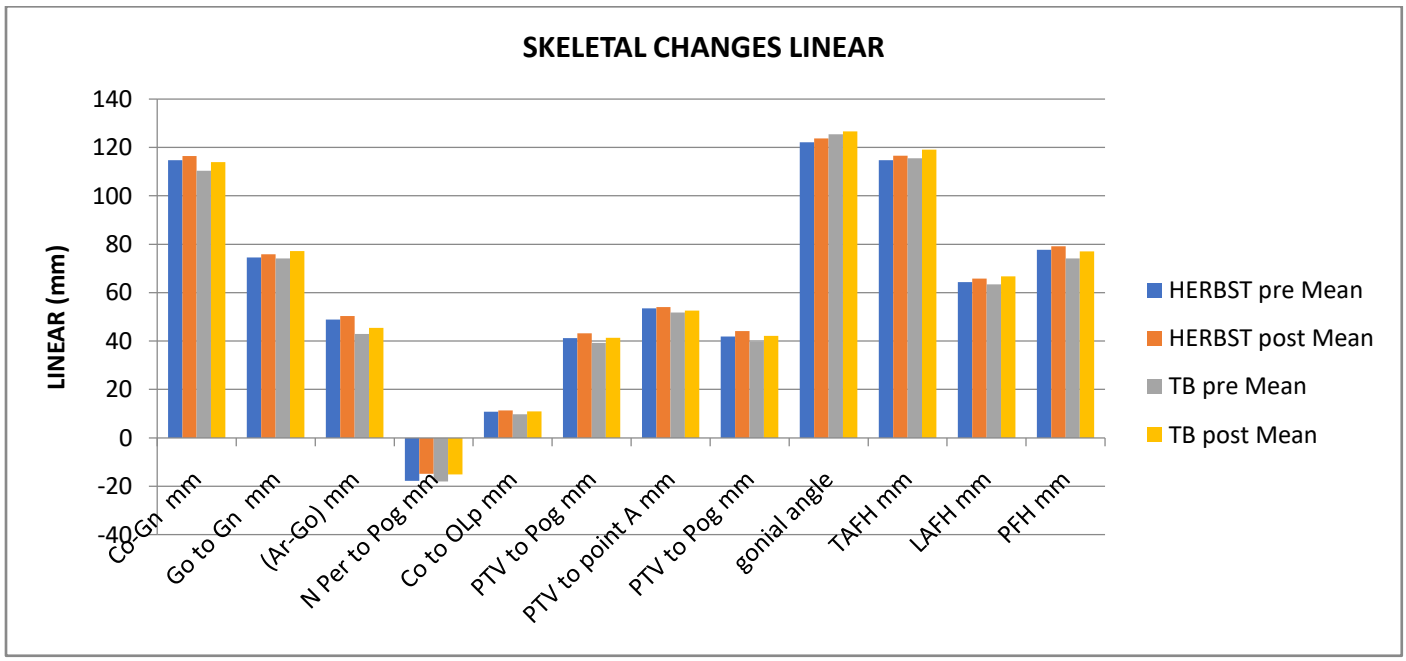
Table: 3 Angular skeletal changes in pre and post mean(SD) of herbst and TB



Graph 1: Angular skeletal changes in pre and post mean(SD) of herbst and TB

Measurements	HERBST pre Mean	SD	HERBST post Mean	SD	TB pre Mean	SD	TB post Mean	SD	P value
Skeletal changes									
Co-Gn effective mandibular length mm	114.75	7.74	116.50	7.70	110.42	5.68	113.92	5.85	<0.001
Go to Gn (corpus length) mm	74.50	5.66	75.92	5.68	74.17	5.31	77.17	5.27	<0.001
ramus height(Ar-Go) mm	48.92	7.91	50.33	7.80	42.92	5.05	45.42	5.52	0.02
N Per to Pog mm	-17.75	5.67	-14.83	-5.73	-18.08	3.90	-15.08	3.75	0.76
Co to OLp mm	10.83	3.21	11.33	3.17	9.67	3.42	10.92	3.12	0.04
PTV to Pog mm	41.25	10.47	43.25	10.69	39.25	3.14	41.33	2.84	0.48
PTV to point A mm	53.57	4.85	54.08	5.05	51.75	3.11	52.58	3.23	0.04
PTV to Pog mm	41.92	7.44	44.08	7.84	39.75	2.77	42.17	2.55	0.18
total anterior facial height mm	114.75	4.90	116.58	5	115.58	6.97	119.08	7.01	0.002
lower anterior facial height mm	64.33	3.94	65.83	3.90	63.42	5.50	66.67	5.53	<0.001
posterior facial height mm	77.75	8.77	79.17	8.83	74.17	6.12	77	6	0.01

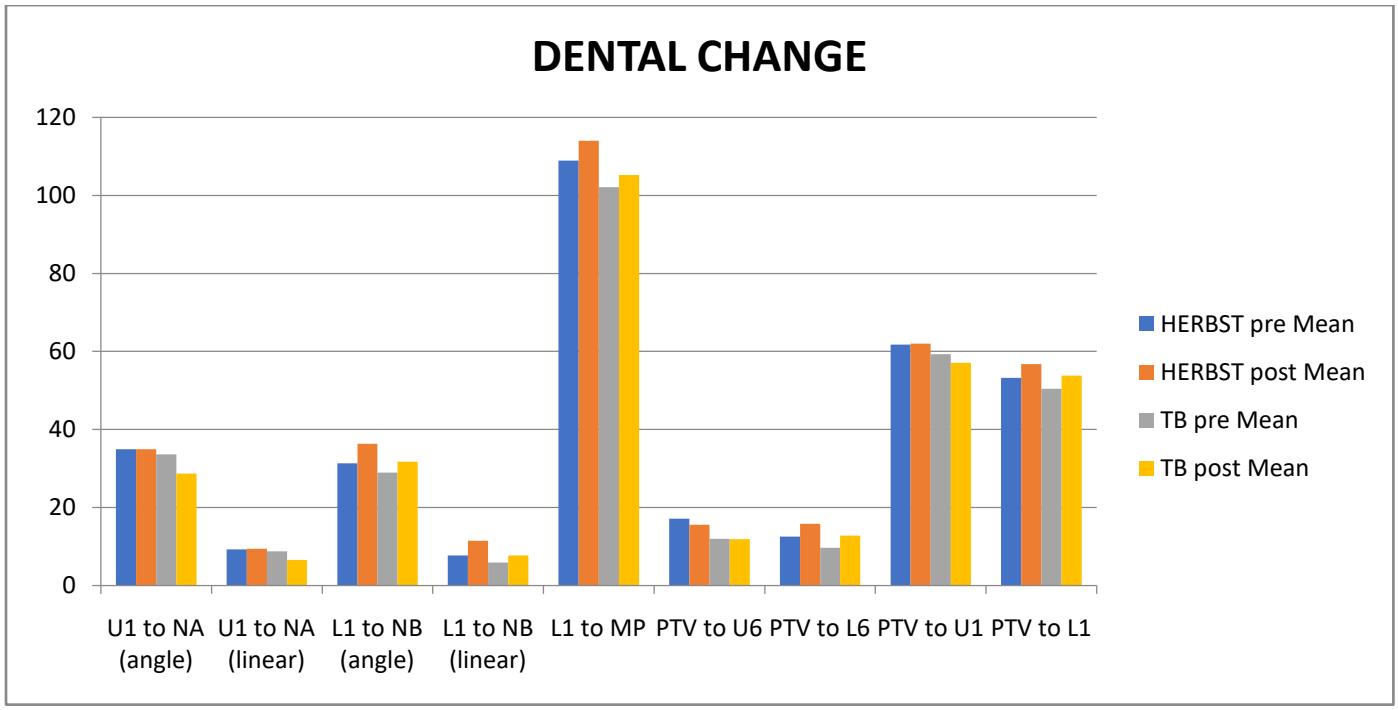
Table 4: Linear skeletal changes in pre and post mean(SD) of herbst and TB



Graph 2: Linear skeletal changes in pre and post mean(SD) of herbst and TB

Measurements	HERBST				TB				P value
	pre		post		pre		post		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Dental Changes									
U1 to NA (angle)	34.92	7.77	34.92	7.73	33.67	4.03	28.67	5.18	<0.001
U1 to NA (linear)	9.25	2.05	9.42	1.83	8.75	2.26	6.58	2.02	<0.001
L1 to NB (angle)	31.33	6.81	36.33	6.27	28.92	3.73	31.75	3.62	<0.001
L1 to NB (linear)	7.75	2.60	11.50	2.71	5.92	1.56	7.67	1.72	<0.001
L1 to MP	108.92	8.99	114	8.83	102.08	3.80	105.25	3.74	0.001
PTV to U6	17.17	3.49	15.58	3.32	12	2.56	11.89	2.60	<0.001
PTV to L6	12.58	5.35	15.83	5.44	9.67	2.96	12.83	3.32	0.76
PTV to U1	61.75	6.41	62	6.34	59.33	3.87	57.08	4.10	<0.001
PTV to L1	53.25	6.03	56.75	6.45	50.42	2.94	53.83	3.19	0.003

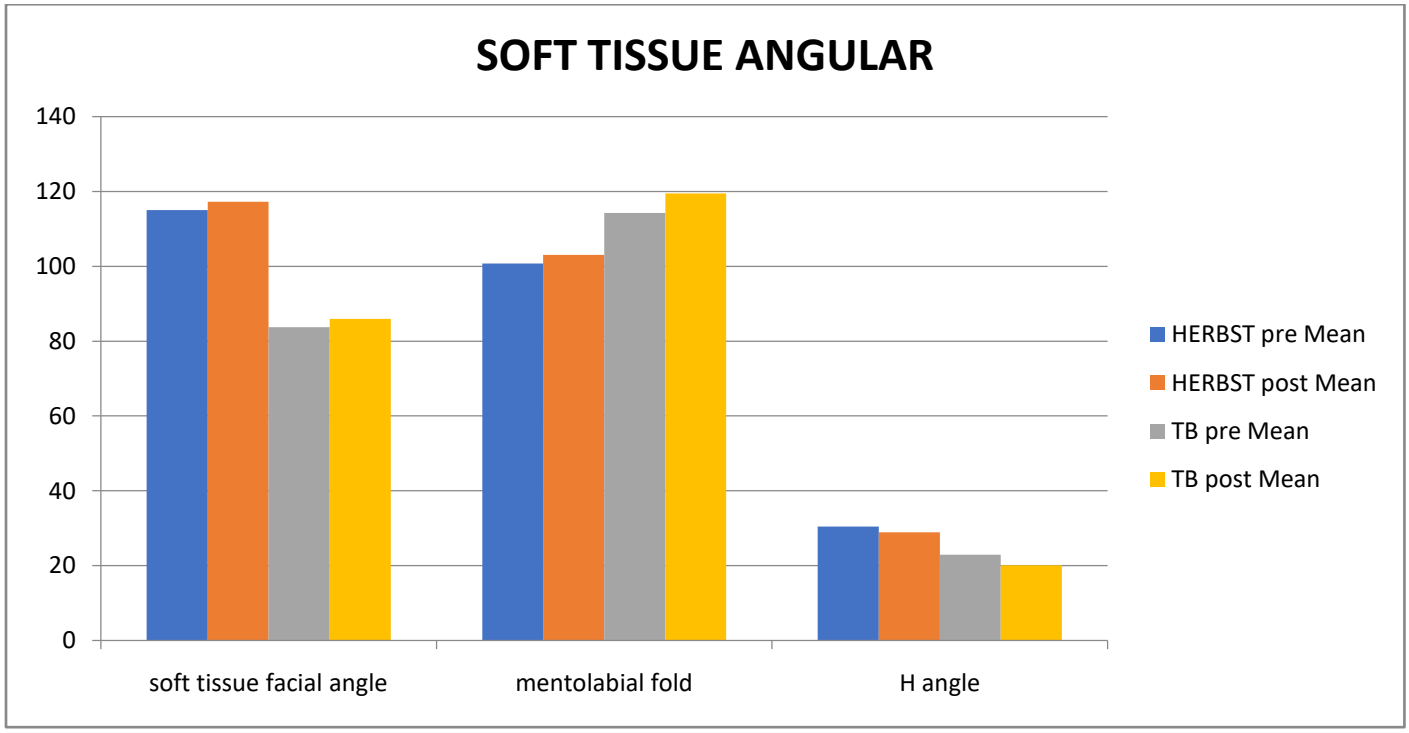
Table 5: Angular & linear dental changes in pre and post mean (SD) of herbst and TB



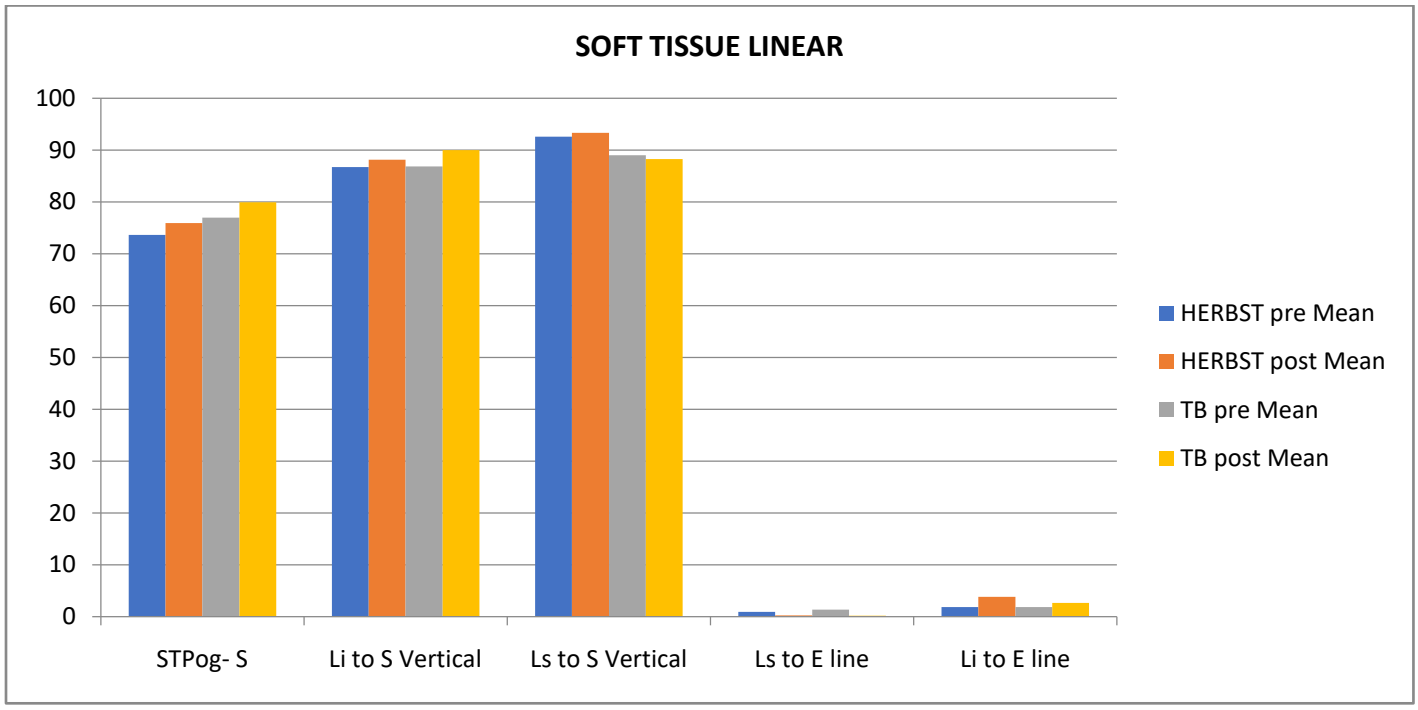
Graph 3: Angular & linear dental changes in pre and post mean (SD) of herbst and TB

Table: 6 Angular & linear soft tissue changes in pre and post mean(SD) of herbst and TB

	HERBST				TB				
Measurements	pre		post		pre		post		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Soft tissue changes									
soft tissue facial angle	115	8.78	117.25	8.58	83.75	1.42	85.92	1.62	0.71
mentolabial fold	100.75	19.20	103.08	19.89	114.25	9.72	119.50	10.09	0.005
H angle	30.42	35.94	28.92	38.28	22.92	2.39	20.08	2.19	0.04
STPog- S	73.67	11.71	75.92	11.68	77	4.31	79.92	4.48	0.12
Li to S Vertical	86.75	9.91	88.17	10.11	86.83	4.61	90	4.22	0.002
Ls to S Vertical	92.58	9.19	93.33	9.17	89	4.73	88.25	5.59	0.007
Ls to E line	0.92	2.23	0.25	2.38	1.38	1.11	0.17	1.53	0.18
Li to E line	1.83	3.01	3.83	2.38	1.83	1.47	2.63	1.53	<0.001



Graph 4: Angular skeletal changes in pre and post mean (SD) of herbst and TB



Graph 5: Angular skeletal changes in pre and post mean (SD) of herbst and TB

Discussion

Though the present study used lateral cephalograms to assess the changes, many other investigators used various other methods like cone beam computer tomography (CBCT), 3D laser scan techniques, 3D stereo photogrammetric images, etc. Most of these investigative methods, being 3D, would have the added advantage of studying transverse dimensions as well.

The present study evaluated the anterio-posterior position of the maxilla in relation to the anterior cranial base. The mean increase of SNA angle and PTV to Point A linear was greater for the Twin block group compared to the Herbst group (Table No: 3 and 4 and Graph No: 1 and 2), and the result was statistically significant, (P = 0.005) and (P = 0.04), respectively. Even though Herbst appliance maxilla, the above values suggest that both appliances had no restraining effect on the anterior growth of the maxilla. Similar results were obtained by most of the investigators.[14, 15 and 16]

The present study evaluated the anterio-posterior position of the mandible in relation to the anterior cranial base. The mean increase in SNB angle suggested a forward growth of the mandible, which occurred with both appliances but was more common with the twin block appliance compared to the Herbst appliance. This result was statistically significant (P = 0.03). Most of the other authors were also of a similar opinion. [8, 17, 17, 18, 19, 20, 21, 22]

Examination of linear measurements suggested a forward growth of the mandible that occurred with both appliances (PTV to point B, PTV to Pog and N per pog), which was statistically significant. But the results were 0.25mm, 0.08mm, and 0.08mm respectively, with the twin block appliance when compared to the Herbst appliance. This difference in the results was statistically insignificant (Table No: 3 and Graph No: 1). This finding was supported by most of the investigators.[14, 21, 23, 24.]

Nicole J. Siara-Olds et al[24] used the Co- point B and found that the mean increase was 0.38mm greater for the Twin block appliance when compared to the Herbst appliance but, was not statistically significant (P=

0.40).Similarly, Aslı Baysal et al[21] and Kevin O'Brien et al[23]used the OLp–Pog and found similar results(1.5mm) which was insignificant. The mean increase in the effective mandibular length (Co-Gn and Go-Gn) occurred with both appliances but was 1.75 mm and 1.58 mm greater for the Twin block appliance when compared to the Herbst appliances, respectively (Table No. 3 and Graph No: 1), and the result was statistically highly significant (P=<0.001**), s**uggesting that the forward growth of the mandible occurred more with the Twin block appliance when compared to the Herbst appliances. This finding was similar to the studies done by most of the investigators[21], [24 and 25] with a mean increase of 1mm and 0.8mm greater for the Twin block appliance when compared to the Herbst appliance respectively, but was not statistically significant (P > 0.05).

The mean change of ramus height (Co to Go) was increased with both the appliances but, was 1.08mmgreater for the Twin Block appliance and was statistically significant (P= 0.02), suggesting a greater elongation of mandibular ramus length with the Twin block appliance. The finding was similar to the studies conducted by AslıBaysal et al[21] and Abbie T. Schaefer et al[25]with a mean increase of 1.3mm but was not statistically significant (P>0.05).The mean change in the sagittal position of condylar head (Co-OLp)showed that the mean increase in sagittal position of condylar head had occurred with both the appliances but, was 0.75mm greater for the Twin Block appliance. This suggest that the increase in sagittal position of condylar head occurred more with the Twin block appliance. This was statistically significant (P=0.04**)**. This finding was similar to the studies done by Aslı Baysal et al[21] and Kevin O'Brien et al[26]with a mean increase of0.6mm greater for the Twin block appliance when compared to the Herbst appliance but, was not statistically significant (P>0.05).

The present study indicates improvement in the class II skeletal relationship with both the appliances. The mean decrease in ANB was greater for the Herbst appliance but was not statistically significant. The decrease in ANB angle is most probably due to an increase in the mandibular length. This finding was similar to the studies done by most of the investigators[25, 24 and 21]and was statistically significant (P<0.01**)**. The mean increase in Beta angle and Wits appraisal were suggesting improvement for both appliances but was greater for the Twin block appliance. This was not statistically significant. Even though Beta angle was not investigated by most authors, the Wits appraisal results were similar to the study done by Nicole J.Siara-Olds et al[24] and was statistically significant.

Though both appliances showed increase in facial height, increases in lower anterior and posterior face heights were a consistent finding after TB therapy. The mean increase in the total anterior facial height (N – Me) of 1.67mm, lower anterior facial height of 1.75mmand posterior facial height (S-Go) of 1.42mmwere greater for the Twin block appliance and was statistically significant (P<0.001). This finding was similar to the study done by most of the investigators[21 and 25] but was not statistically significant. An increase in gonial angle with both the appliances was seen and was greater for the Herbst appliance of 0.33ºbut, was not statistically significant. Contrarily Nicole J. Siara Oldset al[24] observed a greater increase in gonial angle with the Twin block appliance, which not statistically significant.

Retraction of the maxillary incisors occurred only with Twin block appliances [U1 to NA (angle, linear)] with 5º and 2.33mmdifferenceand PTV to U1inhibiting 1.5mm difference] when compared with the Herbst appliance.

This was statistically significant (P<0.001**)**. The mean increase in L1 to NB (angle, linear) occurred with both appliances but, was 2.17° and 2mm greater for the Herbst appliance and was statistically significant (P<0.001). Suggesting proclination of mandibular incisors was more with the Herbst appliance. This finding was similar to the study done by Mariya Qadiret al[27]and Aslı Baysal et al[21]. The L1 to mandibular plane was 1.92°greater for the Herbst appliance and was statistically significant (P= 0.001) suggesting proclination of mandibular incisors was more with the Herbst appliance. This finding was similar to the studies done by most of the investigators[28 and 29].The lower incisor inclination was (PTV to L1)1.08mm greater for the Herbst appliance and was statistically significant (P=0.003). This finding was similar to the studies done by Khurram Shahzadet al[30] and Aslı Baysal et al[21] and was statistically significant. All these values indicates that proclination of the mandibular incisors occurred in both appliances, but was more with the Herbst appliance. Proclination of lower incisors we as reduced probably due to incisal capping in the lower twin block appliance.

In comparison, there was distalization of maxillary first molars (PTV to U6)for both appliances, but distalization was more evident with the Herbst appliance 1.48 mm and the results were statistically significant (P< 0.001). This finding was similar to the studies done by Aslı Baysal et al,[21]but the results were not statistically significant. Distalization of upper dental arch may be related to the 'headgear effect' of the Herbst appliance. Mesialization of the lower molar occurred with both the appliances (PTV to L6), but mesialization was 0.08mmgreater for the Herbst appliance, but the values were not statistically significant. The mesial movement of the mandibular molar could probably be due to the effect of mandibular growth. This finding was similar to the studies done by Aslı Baysalet al[21] but, was not statistically significant.

Soft tissue facial angle improved with both the appliances [soft tissue facial angle (FH-N'-Pog)]and was 0.08° greater for the Herbst appliance when compared to the Twin block appliance but, was not statistically significant. This finding was similar to the study done by Nicole J. Siara-Olds[24], with a mean increase of 0.84° greater for the Herbst appliance

Most of the soft tissue profile variables improved with both the appliances but was more significant with the Twin block appliance. The mentolabial fold became less pronounced, the upper lip prominence decreased and the forward movement of the chin occurred. This finding was similar to the study done by Aslı Baysalet al[31].

The forward movement of the lower lip occurred more with the Herbst appliance (Li to S vertical and Li to E lines). These findings were similar to the studies done by Aslı Baysalet al[31] and Abbie T. Schaefer et al.[25]

Conclusion

From this study, we can conclude that:

- There has been a significant increase in the forward growth of the mandible with the Twin block appliance compared to the Herbst
- Both appliances did not restrict the forward growth of the maxilla.
- There has been a significant decrease in the skeletal class II pattern with both appliances.
- There has been a significant increase in the lower anterior facial height, lower posterior facial height, and total anterior facial height, but more with the Twin block appliance compared to the Herbst appliance.
- There has been a significant decrease in the inclination of the upper incisors with the Twin block appliance compared to the Herbst

- The Herbst appliance showed a greater and more significant increase in the inclination of the lower incisors compared to the Twin block appliance.
- The overjet decreased significantly with both appliances.
- The upper molars moved more backward with the Herbst appliance compared to the Twin block appliance.
- The facial convexity and depth of the mentolabial increased more with the Twin block appliance compared to the Herbst appliance.
- There has been a significant amount of forward movement of the lower lip and backward movement of the upper lip with both appliances.

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