Scope
Volume 14 Number 04 December 2024

Comparative evaluation of Efficacy of Tandem Traction Bow Appliance Compared with Reverse Pull headgear in Skeletal Class III Children - A Cephalometric Prospective Study

Dr. Ritu Garg; Dr. Shruti Patil; Dr. Ameet .V. Revankar; Dr. Vijay .P. Jayade

Corresponding Author: **Dr.Ritu Garg**

Abstract:

Background and objectives: There have been various modalities to treat growing Class III patients with maxillary deficiency, one of the them being Tandem Traction Bow appliance(TTBA). Patient compliance is better with this appliance since it is more comfortable and esthetic. Good clinical results have been seen, but these have not been reported.Hence, the purpose of this study was to make a detailed evaluation of hard and soft tissue changes with TTBA in the non-cleft and the cleft growing Class III individuals. **Methods:** The treatment group (group I), which comprised ten children (mean age - 8.9 years) with skeletal Class III relationships caused by maxillary retrognathism, was compared with another group (group II) of ten children (mean age - 8.5 years) treated using the Reverse pull head Gear(RPH) and with the untreated control group (group III). Pre and post-treatment lateral cephalograms were traced and analyzed. The differences were compared using the student's paired t-test. Group I and group II were compared by using unpaired t-test. **Results:** After maxillary protraction, statistically significant anterior movement of the maxilla occurred with an increase in the angle SNA (+2.5°), Maxillary length (+3.6mm) and angle ANB (+3.9°), and anterior movement of A point (3.1mm). Maxillary incisors moved in anterior direction, whereas the mandibular incisors moved posteriorly, which is indicated by Upper incisor to SN (+2°) and Lower incisor to Mandibular plane (-1.9°) respectively.Mandibular changes were non-significant with respect to the angle SNB. Vertical relationship increased minimally with the TTBA. The Class III concave profile became more balanced, with the upper lip area becoming more marked. The TTBA appliance results in a significant improvement of the dentofacial complex that is comparable to or more than the improvement obtained by the RPH. In comparison with the control group, the maxillary length, angle SNA and the angle of facial convexity increased in the patients treated with the TTBA. **Conclusion:** TTBA is a valuable alternative in treating growing Class III patients with maxillary deficiency, as it promotes patient compliance and is more esthetic and comfortable than the extraoral appliances. **Clinical implications**: The TTBA is an effective, esthetic, efficient, intraoral semi-fixed functional appliance.It can be used effectively in the treatment of growing skeletal Class III malocclusions whose Class III is on account of mid-facial deficiency.

Keywords: Class III malocclusion, Cleft, Reverse overjet , TTBA, Reverse Pull Head Gear

Introduction

The management of class III is perhaps the most challenging, which has been influenced by this changing paradigm.The famous saying of orthodontics "Catch them young" did not hold true in the past for patients with class III malocclusions. Maxillary retrusion and abnormal growth patterns are the most common contributing components of class III features.This unpredictable and unfavourable nature of growth in patients with this skeletal pattern makes treatment of skeletal class III malocclusion a tricky task. Various orthopedic appliances like the face mask (Delaire), reverse pull head gear and modified designs of functional appliances such as FR-III, reverse twin block, TMA spring and TTBA have been used to treat this condition.Both face mask and reverse pull head gear have provided optimal results in the correction of class III malocclusion, but there have been reports of failures with this modality of treatment primarily due to poor patient compliance. This has been attributed to their extra oral components, which make the appliance unaesthetic and sometimes inconvenient for the patient.

To overcome these lacunae in the above mentioned treatment modalities, Tandem Traction Bow Appliance (TTBA) was introduced. TTBA is an intra-oral device with one maxillary and two mandibular removable components, thus making oral hygiene maintenance easy for the patient. Moreover, its intra oral nature makes the appliance highly esthetic, and its removable nature makes it patient friendly.The appliance, in keeping with dynamics in growth, underwentmodification and became known as Modified Tandem Appliance (MTA), which has three components, one fixed and two removable. The upper component is fixed, which improves patient compliance. This appliance also produced good results.

Maxillary modified protraction headgear (MMPH) which could be used effectively in Class III patients with retrognathicmaxilla and anterior open bite.The effects of a modified reverse headgear force applied with a facebow on the dentofacial structures of patients with skeletal Class III malocclusions characterized by maxillary retrognathism was studied.

Maxillary protractors were used beneficially at the period of the dentocraniofacial growth spurt and distinguished the effects of protraction on separate groups of patients with unilateral and bilateral clefts, and compared it with growth and development in a corresponding group of non-cleft patients using a fixed quad-helix appliance in combination with the face mask. There was no longer a significant difference in the maxillary protraction between the two cleft lip and palate groups after protraction. Two different approaches i.e., the customized face mask and headgear to the mandibular dentition were used for correction of skeletal class III malocclusion. They found that despite the very different methods of applying the extra-oral force, the two treated groups

showed similar therapeutic effects. The controlled randomized clinical trial to quantify the effects of maxillary protraction with or without palatal expansion was performed with a 5-year clinical trial, and their results indicated that early facemask therapy, with or without palatal expansion, is effective to correct skeletal Class III malocclusions.

It can be observed from the literature that, there hasnot been a comparative study between TTBA and reverse pull head gear in treating class III malocclusion. Hence, the present study was planned with the objectives:

(1) To study the skeletal, dental and soft tissue effects of TTBA in class III children,

(2) To compare the changes with a group of patients who had previously been treated with the RPH and

(3) To quantify the above changes in untreated class III individuals and patients with cleftlipandpalate that have mid-face deficiency.

Methodology

Inclusion Criteria

Patients with true skeletal Class III malocclusion due to maxillary hypoplasia, indicated by the cephalometric valuesfor true skeletal Class III: Angle ANB (<1°), Wits (< -1mm), A perpendicular to B perpendicular on FH (3.5mm with A ahead). Values for maxillary hypoplasia: Angle SNA (78°), A perpendicular to N perpendicular on FH(6mm with N ahead). All patients were growing children in early mixed or late mixed dentition between 7.5 years to 9.5 years of age (systemically healthy).Patients with cleft lip or palate having similar skeletal character as mentioned above were also included in the study. The age and sex distribution of the patients for TTBA is tabulated in Table 1.

Table 1 Age and sex distribution of the patients for Tandem Traction Bow appliance and Reverse Pull Head Gear appliance

Sex	**Number**	**Age range (Years)**	**Mean age (Years)**
Tandem Traction Bow Appliance			
Male	05	7.5-9.5	9.2
Female	05	8.0-9.5	8.6
Total	10	7.5-9.5	8.9
Reverse Pull Head Gear Appliance			
Male	06	7.0-9.5	8.4
Female	04	8.0-9.5	8.6
Total	10	7.0-9.5	8.5

Appliance Construction

The Tandem Traction Bowappliance used in the study was first introduced by Chun et al[1]in 1999. The appliance consisted of an upper splint (Figure 1A) a lower splint and a traction bow(Figure 1A). As per Klempner[2]modification, the upper splint in this appliance was fixed. The upper splint was constructed using self-cure acrylic. The splint extended from the deciduous canine to the first permanent molar bilaterally. The hooks made in 19 gauge stainless steel wire were incorporated in the appliance distal to the canines for attaching the head gear elastics. A stainless steel wire was incorporated in the palatal region to connect the two parts of the upper splint. The lower splint component of the appliance was also constructed using self-cure acrylic. It covered the occlusal and lingual surfaces of the teeth. A 'C' clasp was incorporated in the molar region, and ball end clasps were used in the incisor region to improve the retention of the appliance. Head gear tubes were incorporated in the first permanent molar region for insertion of the traction bow. A traction bowis a modification of a conventional head gear outer face bow. Head gear elastics were used from hooks on the upper splint to the lower traction bow to protract the maxilla. The force used was 450-500 gm/side, and the patient was advised to wear the appliance for 12-14 hrs/day. The constructed TTBA is shown in Figure 1B.

Figure 1: Tandem Traction Bowappliance.
Upper splint (A) and Lower splint with traction bow (B)

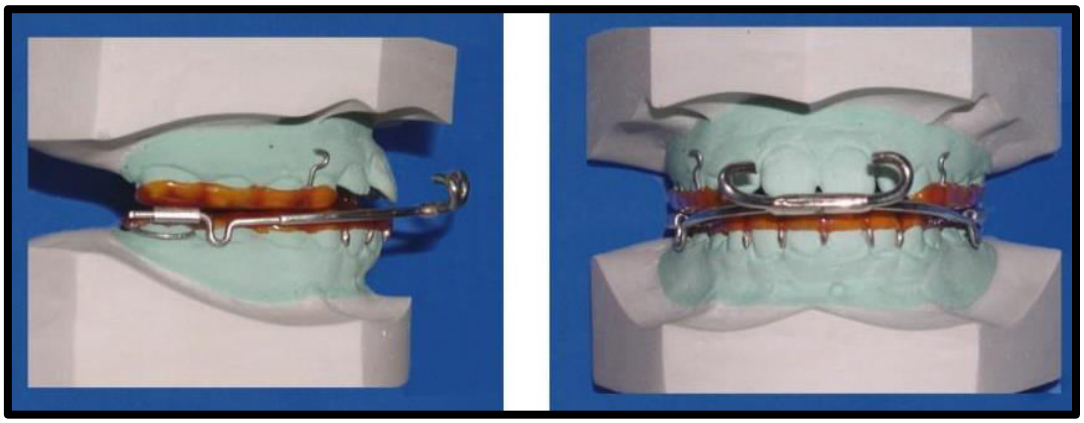
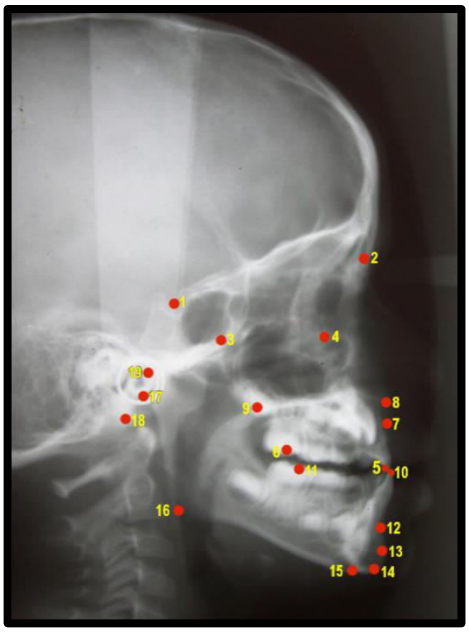


Figure B: Tandem Traction Bowappliance fitted into the models.

Figure 2 Pre-treatment and post-treatment cephaograms.



1. Sella (S)
2. Nasion (N)
3. Pterygomaxillare (Ptm)
4. Orbitale (Or)
5. Upper incisor tip
6. Molar superius
7. Subspinale ('A')
8. Anterior nasal spine (ANS)
9. Posterior nasal spine (PNS)
10. Lower incisor tip
11. Molar inferius
12. Supramentale ('B')
13. Pogonion (Pog)
14. Gnathion (Gn)
15. Menton (Me)
16. Gonion (Go)
17. Articulare (Ar)
18. Basion (Ba)
19. Condylion (Cd)

Figure 3: Hard tissue landmarks (A)

1. Soft tissue nasion ('N')
2. Pronasale (P)
3. Subnasale (Sn)
4. Labralesuperius (Ls)
5. Labraleinferius (Li)
6. Soft tissue pogonion (Pog)
7. Soft tissue menton (Me)

Figure 3: Soft tissue landmarks (B)

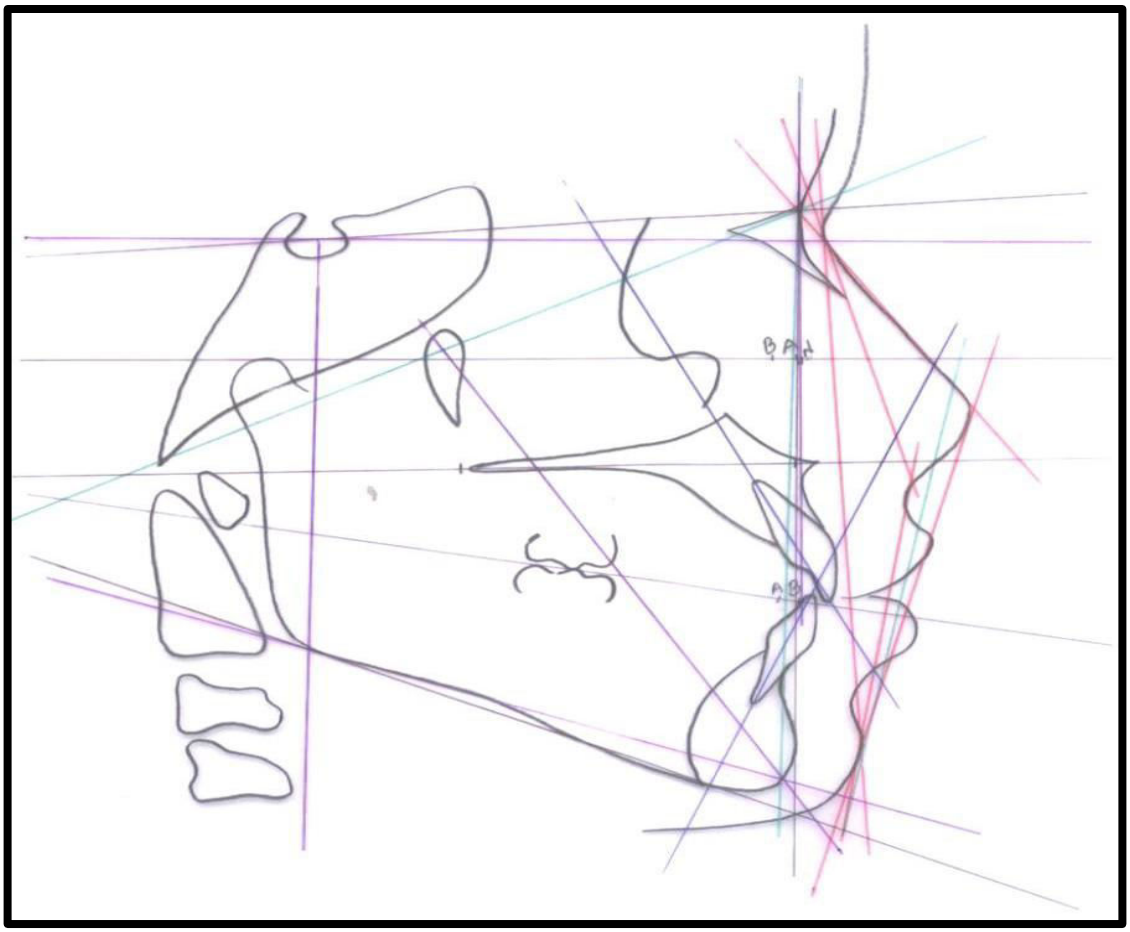
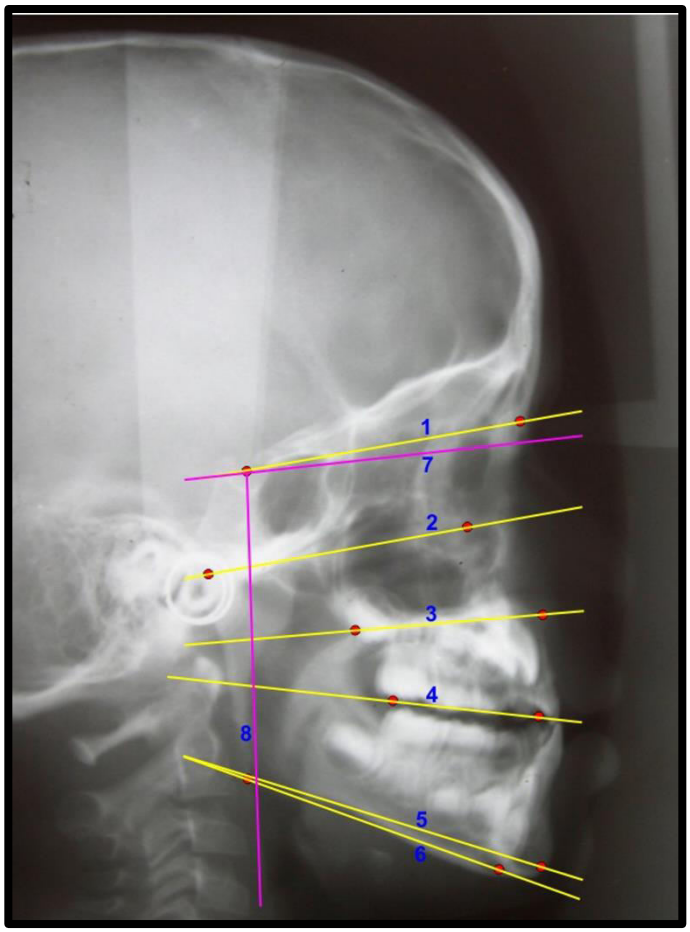
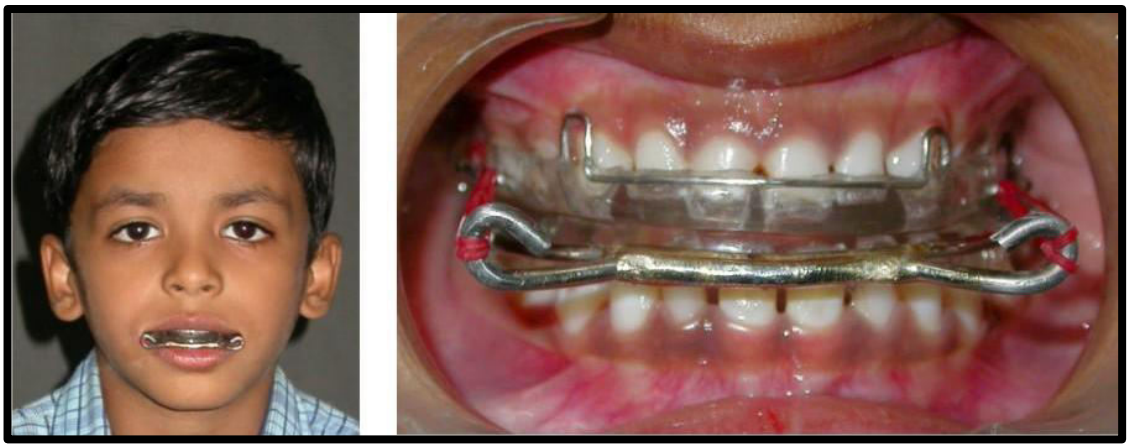


Figure 5 Composite cephalometric analysis.

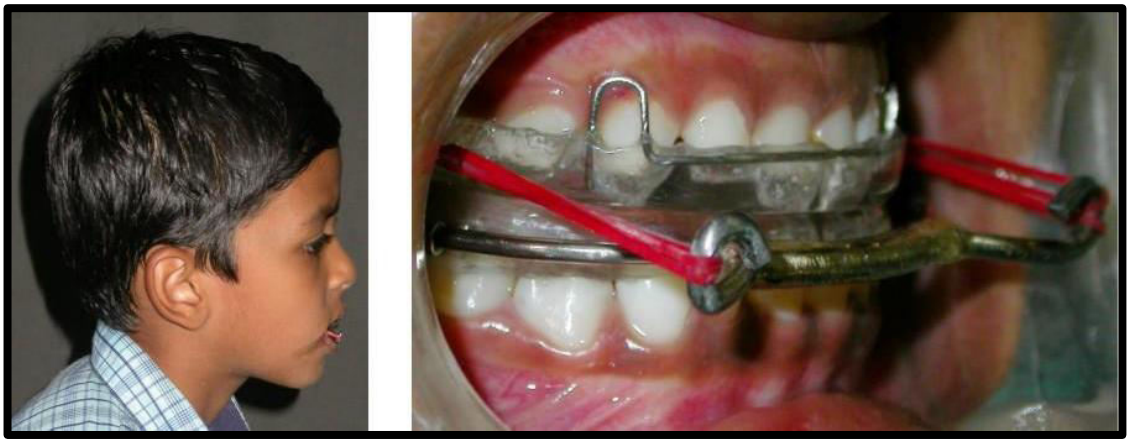


1. Sella-Nasion plane
2. Frankfurt horizontal plane
3. Palatal plane
4. Functional occlusal plane
5. Mandibular plane
6. Horizontal reference plane
7. Vertical reference plane (Y axis)

Figure 6 Reference planes.



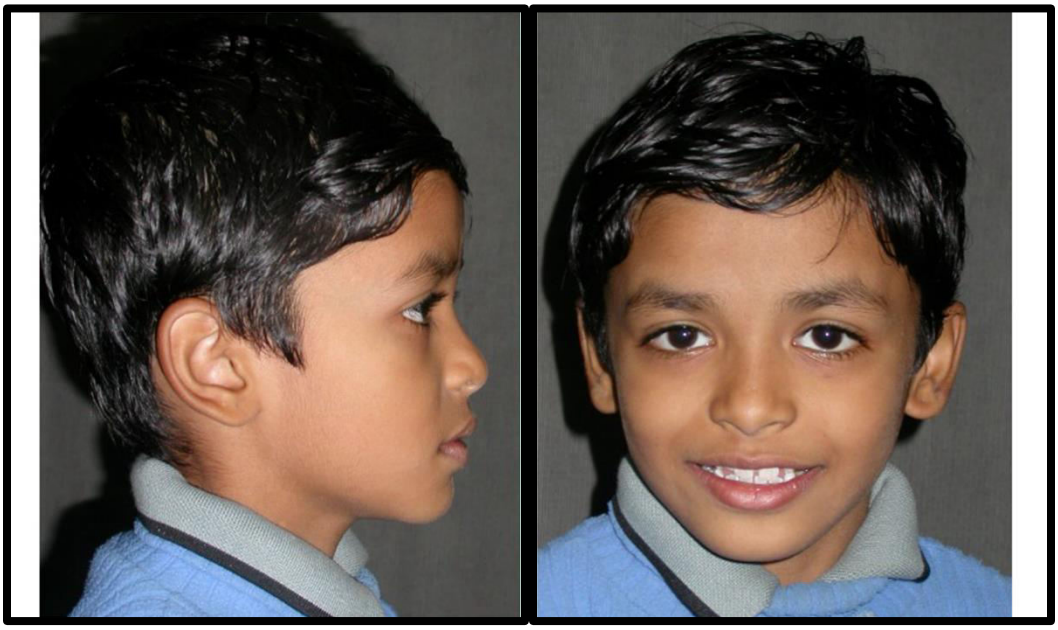
(a) Extraoral



(b) Intraoral

Figure 7 Extraoral and intraoral photographs with Tandem Traction Bow appliance.

(a) Pre-treatment



(b) Post-treatment

Figure 8 Pre-treatment and post-treatment photographs.

Cephalometric Records

The procedure was followed uniformly for the entire sample. Two right side lateral cephalograms were taken, one just before the insertion of the tandem traction bow appliance (T1), and the second one immediately after the functional phase was over (T2). This was done with the subject in standing position, keeping the visual axis parallel to the floor. A standard radiographic exposure comprising of usual parameters vide 70 kvp, 10ma and an exposure time of 1.6 seconds was used. The distance between the X-ray source and the patient's mid-sagittal plane was 5 feet, and that from the mid-sagittal plane to the X-ray film cassette was 6.5 inches.

Next, the tracings were made on 75µm lacquered polyester acetate tracing papers using a 0.03" lead pencil. A single operator performed the tracings in a standardized manner to avoid errors due to any inter-operator variations. The hard and soft tissue landmarks, reference planes and angular measurements, as defined by RakosiT[3] and Jacobson A[4] and were recorded. The hard tissue landmarks are presented in Figure 2A and the soft tissue landmarks are presented in Figure 2B. The composite cephalometric analysis and reference planes are shown in Figures 3 and 4, respectively.

Statistical Tests

The pre and post functional measurements were then tabulated and analyzed statistically. The following statistical tests were done.

1. Paired student t-test: It was carried out to know whether there was any significant difference between the pre-treatment and post-treatment means.

The formula used was:

$$t = \frac{\overline{d}}{s/\sqrt{n}}$$

Where:

d= Difference between pre and post treatment values

d= Mean of 'd'

s= Standard deviation of the difference

n= Paired number of observations

Statistical significance was considered to be highly significant at 0.01% (P<0.01) level, significant at 5% (P<0.05) level and non-significant above 5% (P>0.05) level.

2. Students unpaired't' - test – was applied to see the significant difference between two independent groups. It showed if there was any significant difference between two independent sample means i.e., whether x and x are significantly different.

Results

The extraoral and intraoral photographs with TTBA are shown in Figure 5 and the pre-treatment and post-treatment photographs are presented in Figure 6. The pre-treatment and post-treatment cephaograms are presented in figure 7.

The results of our study are categorized into the following groups:

I. TTBA group
II. Reverse Pull Head Gear group
III. Statistical comparison between pre and post treatment changes with each appliance
IV. Statistical comparison between TTBA and Reverse Pull Head Gear groups

Each group is evaluated with respect to the following:

A. Skeletal changes
B. Dental changes
C. Soft tissue changes

The statistical comparison indicatingpre and post treatment changes in the maxillo-mandibular relationship, maxilla, mandible, and vertical relationship in TTBA group (Results of paired t-test) are presented in table 2, dentoalveolar changes and soft tissue changes in TTBA group presented in table 3. The Statistical comparison between pre and post-treatment changes in the themaxillo-mandibular relationship, maxilla, mandible, and vertical relationshipin RPH appliance was done by paired t tests and are tabulated in table 4 and dentoalveolar changes and soft tissue changes in TTBA group presented in table 5.Statistical comparison in the changes in the maxillo-mandibular relationship, maxilla, mandible, and vertical relationship between TTBA and Reverse Pull Head Gear groupsby using unpaired t-test are presented in Table 6, dentoalveolar changes and soft tissue changes in Table 7.

Table 2: Statistical evaluation of changes in the maxillo-mandibular relationship, maxilla, mandible, and vertical relationship in TTBA group (Results of paired t-test)

Variable	Period	Mean	Std.Dv.	Mean Diff.	Std.Dv. Diff	Paired t-value	df	P-value	Significance
Angle ANB	Pre	-1.1	1.220	-3.95	3.261	-3.830	9	0.004	HS
	Post	2.9	2.604						
Angle N-A-	Pre	-3.7	4.137	-6.45	3.947	-5.167	9	0.001	HS

Pog	Post	2.8	3.084						
Angle N-A-Pog-FH	Pre	85.8	3.393	-0.25	1.990	-0.397	9	0.700	NS
	Post	86.1	2.733						
B⊥ to A ⊥ on Occlusal	Pre	-4.8	2.189	-3.90	1.983	-6.219	9	0.000	HS
	Post	-0.9	1.582						
Angle SNA	Pre	77.7	3.917	-2.50	1.780	-4.443	9	0.002	HS
	Post	80.2	3.553						
Maxillary length (PNS-ANS)	Pre	44.6	3.026	-3.65	0.884	-13.064	9	0.000	HS
	Post	48.3	2.841						
Effective Max Length	Pre	77.7	6.201	-3.50	1.000	-11.068	9	0.000	HS
	Post	81.2	5.549						
Y Axis to A	Pre	61.7	4.762	-3.15	1.733	-5.748	9	0.000	HS
	Post	64.9	4.069						
A⊥ to N⊥ on FH	Pre	6.4	4.289	2.95	2.443	3.818	9	0.004	HS
	Post	3.4	2.183						
SNB	Pre	78.8	3.111	0.55	2.047	0.850	9	0.418	NS
	Post	78.3	3.138						
Mandibular body length	Pre	68.0	4.497	1.05	1.921	1.728	9	0.118	NS
	Post	69.1	4.434						
Effective Mandibular Length	Pre	96.1	5.782	-1.50	2.058	-1.893	9	0.091	NS
	Post	97.6	4.826						
Y axis to B	Pre	58.8	6.228	0.45	3.362	0.423	9	0.682	NS
	Post	58.3	5.458						
Y axis to Pg	Pre	59.1	5.990	0.20	3.393	0.186	9	0.856	NS
	Post	58.9	5.405						
B ⊥to N⊥ on FH	Pre	9.3	5.731	1.60	2.025	2.499	9	0.034	S
	Post	7.7	4.720						
SN-GoGn	Pre	27.7	3.917	-0.10	1.969	-0.161	9	0.876	NS
	Post	27.8	3.327						
FMA	Pre	24.7	3.498	-0.30	1.703	-0.557	9	0.591	NS
	Post	25.0	3.712						
FH to Palatal Plane	Pre	0.3	5.443	-1.10	5.734	-0.607	9	0.559	NS
	Post	1.4	4.035						
Facial Axis	Pre	90.2	3.824	0.80	2.700	0.937	9	0.373	NS

	Post	89.4	3.502						
X axis to ANS	Pre	40.2	3.765	-1.20	1.814	-2.093	9	0.066	NS
	Post	41.4	3.922						
X axis to PNS	Pre	37.8	5.760	-1.50	3.375	-1.406	9	0.193	NS
	Post	39.3	4.626						
X axis to Pg	Pre	92.7	6.255	-1.30	1.370	-4.385	9	0.045	S
	Post	94.0	6.077						
LFH	Pre	64.3	5.039	-1.40	1.476	-4.714	9	0.034	S
	Post	65.7	5.165						

HS= Highly Significant (p<0.01), S= Significant (p<0.05), NS= Non Significant (p>0.05)

Table3: Statistical evaluation of dentoalveolar changes and soft tissue changes in TTBA Group (Results of paired t-test)

Variable	**Period**	**Mean**	**Std.Dv.**	**Mean Diff.**	**Std.Dv. Diff**	**Paired t-value**	**df**	**P-value**	**Significance**
U1 to SN	Pre	105.10	11.676	-2.00	8.446	-0.749	9	0.473	NS
	Post	107.10	10.290						
U1 to FH	Pre	112.20	12.182	-2.00	7.118	-0.889	9	0.397	NS
	Post	114.20	10.433						
L1 to MP	Pre	95.70	6.750	1.90	3.281	1.831	9	0.100	NS
	Post	93.80	6.339						
L1 to FH	Pre	59.40	4.477	-1.50	2.506	-1.893	9	0.091	NS
	Post	60.90	4.677						
U1 to NA angular	Pre	26.90	9.723	-0.20	7.843	-0.081	9	0.938	NS
	Post	27.10	8.412						
L1 to NB angular	Pre	25.95	6.405	2.10	3.187	2.084	9	0.067	NS
	Post	23.85	6.351						
Inter incisal angle	Pre	128.20	16.538	0.50	8.910	0.178	9	0.863	NS
	Post	127.70	13.969						
U1 to NA linear	Pre	4.75	2.486	1.05	1.921	1.728	9	0.118	NS
	Post	3.70	2.869						
L1 to NB linear	Pre	4.55	1.707	0.75	0.825	2.875	9	0.018	S
	Post	3.80	1.735						
X axis to Mand	Pre	64.00	4.922	-1.90	3.035	-1.980	9	0.079	NS

Incisor	Post	65.90	4.677						
X axis to Max Incisor	Pre	64.75	4.872	-1.95	2.166	-2.847	9	0.019	S
	Post	66.70	4.739						
Y axis to Max Incisor	Pre	64.50	7.576	-2.60	3.978	-2.067	9	0.069	NS
	Post	67.10	5.782						
Y axis to Mand Incisor	Pre	65.75	6.630	0.65	3.400	0.605	9	0.560	NS
	Post	65.10	4.932						
Y axis to Mand molar	Pre	36.10	5.021	-0.40	2.914	-0.434	9	0.674	NS
	Post	36.50	4.601						
Upper Molar to Palatal Plane	Pre	20.00	5.598	0.55	2.692	0.646	9	0.534	NS
	Post	19.45	3.989						
Over Jet	Pre	-0.20	2.312	-2.20	2.690	-2.587	9	0.029	S
	Post	2.00	1.764						
Overbite	Pre	-0.80	1.229	-1.80	1.476	-3.857	9	0.004	HS
	Post	1.00	1.633						
Total tissue profile angle	Pre	137.10	8.774	3.90	8.020	1.538	9	0.159	NS
	Post	133.20	5.712						
soft tissue profile angle	Pre	164.80	6.477	3.10	3.755	2.611	9	0.028	S
	Post	161.70	5.832						
Soft tissue Facial angle	Pre	89.40	2.952	0.10	2.378	0.133	9	0.897	NS
	Post	89.30	3.498						
Sup sulcus depth	Pre	2.80	1.549	-0.10	0.994	-0.318	9	0.758	NS
	Post	2.90	1.126						
Subnasale H-line	Pre	4.80	2.336	-0.95	1.878	-1.600	9	0.144	NS
	Post	5.75	2.348						
Skeletal Profile Convexity	Pre	-1.40	1.410	-2.45	0.762	-10.168	9	0.000	HS
	Post	1.05	1.301						
Upper lip thickness	Pre	12.45	1.279	-0.60	1.729	-1.098	9	0.301	NS
	Post	13.05	1.802						
Basic U lip thickness	Pre	13.75	1.990	0.95	1.166	2.578	9	0.030	S
	Post	12.80	1.751						
H Angle	Pre	13.40	4.789	-2.60	2.413	-3.407	9	0.008	HS
	Post	16.00	3.742						
S-line to Upper Lip	Pre	-0.15	1.901	-1.30	0.823	-4.993	9	0.001	HS
	Post	1.15	1.634						
S-Line to Lower	Pre	2.95	2.266	1.00	1.528	2.070	9	0.068	NS

Lip	Post	1.95	1.301						
E-line to Upper Lip	Pre	-1.55	3.883	-0.90	1.524	-1.868	9	0.095	NS
	Post	-0.65	2.729						
E-Line to Lower Lip	Pre	1.85	2.625	1.10	1.807	1.925	9	0.086	NS
	Post	0.75	1.419						

HS= Highly Significant (p<0.01), S= Significant (p<0.05), NS= Non Significant (p>0.05)

Table4: Statistical evaluation of changes in the maxillo-mandibular relationship, maxilla, mandible, and vertical relationship in Reverse Pull Head Gear group (Results of paired t-test)

Variable	**Period**	**Mean**	**Std.Dv.**	**Mean Diff.**	**Std.Dv. Diff**	**Paired t-value**	**df**	**P-value**	**Significance**
Angle ANB	Pre	-0.50	1.716	-3.00	2.108	-4.500	9	0.002	HS
	Post	2.50	2.173						
Angle N-A-Pog	Pre	1.00	5.518	-7.10	19.122	-1.174	9	0.271	NS
	Post	8.10	15.431						
Angle N-A-Pog-FH	Pre	87.00	3.712	0.40	2.591	0.488	9	0.637	NS
	Post	86.60	2.171						
B⊥ to A ⊥ on Occlusal	Pre	-2.80	5.181	-2.15	3.198	-2.126	9	0.062	NS
	Post	-0.65	2.539						
Angle SNA	Pre	78.50	2.635	-2.45	2.587	-2.995	9	0.015	S
	Post	80.95	3.700						
Maxillary length (PNS-ANS)	Pre	45.30	2.214	-2.35	1.564	-4.750	9	0.001	HS
	Post	47.65	2.001						
Effective Max Length	Pre	79.50	5.339	-3.35	2.729	-3.882	9	0.004	HS
	Post	82.85	4.042						
Y Axis to A	Pre	60.50	4.720	-2.15	1.564	-4.346	9	0.002	HS
	Post	62.65	4.123						
A⊥ to N⊥ on FH	Pre	4.60	2.633	0.60	2.787	0.681	9	0.513	NS
	Post	4.00	2.461						
SNB	Pre	79.00	3.559	0.10	1.595	0.198	9	0.847	NS
	Post	78.90	2.767						
Mandibular	Pre	72.20	5.846	-1.70	1.252	-4.295	9	0.00	HS

body length	Post	73.90	5.065					2	
Effective Mandibular Length	Pre	102.20	9.175	-1.50	3.240	-1.464	9	0.177	NS
	Post	103.70	7.499						
Y axis to B	Pre	55.10	7.172	1.10	2.961	1.175	9	0.270	NS
	Post	54.00	6.110						
Y axis to Pg	Pre	55.40	8.113	1.10	2.998	1.160	9	0.276	NS
	Post	54.30	7.349						
B to N (FH)	Pre	6.93	5.570	-1.42	4.376	-1.026	9	0.332	NS
	Post	8.35	4.631						
SN-GoGn	Pre	32.20	4.367	-0.90	4.068	-0.700	9	0.502	NS
	Post	33.10	6.855						
FMA	Pre	28.90	4.095	-1.50	4.327	-1.096	9	0.301	NS
	Post	30.40	5.719						
FH to Palatal Plane	Pre	5.25	8.606	-2.25	5.818	-1.223	9	0.252	NS
	Post	7.50	13.024						
Facial Axis	Pre	90.20	4.517	1.60	4.115	1.230	9	0.250	NS
	Post	88.60	4.742						
X axis to ANS	Pre	41.50	4.428	-2.50	2.014	-3.926	9	0.004	HS
	Post	44.00	4.447						
X axis to PNS	Pre	38.90	4.434	-1.50	1.581	-3.000	9	0.015	S
	Post	40.40	4.115						
X axis to Pg	Pre	95.60	7.662	-4.00	2.789	-4.536	9	0.001	HS
	Post	99.60	7.633						
LFH	Pre	66.90	3.755	-1.20	1.619	-2.343	9	0.044	S
	Post	68.10	3.604						

HS= Highly Significant ($p<0.01$), S= Significant ($p<0.05$), NS= Non Significant ($p>0.05$)

Table5: Statistical evaluation of dentoalveolar changes and soft tissue changes in Reverse Pull Head Gear group (Results of paired t-test)

Variable	**Period**	**Mean**	**Std.Dv.**	**Mean Diff.**	**Std.Dv. Diff**	**Paired t-value**	**df**	**P-value**	**Significance**
U1 to SN	Pre	107.30	6.701	-3.80	8.728	-1.377	9	0.202	NS

	Post	111.10	8.198						
U1 to FH	Pre	113.20	5.865	-3.70	8.394	-1.394	9	0.197	NS
	Post	116.90	7.549						
L1 to MP	Pre	87.30	9.056	0.70	4.138	0.535	9	0.606	NS
	Post	86.60	10.658						
L1 to FH	Pre	63.90	8.034	0.40	5.168	0.245	9	0.812	NS
	Post	63.50	6.754						
U1 to NA angular	Pre	27.10	6.903	-2.40	7.691	-0.987	9	0.350	NS
	Post	29.50	9.132						
L1 to NB angular	Pre	22.00	6.110	-0.30	5.056	-0.188	9	0.855	NS
	Post	22.30	7.009						
Inter incisal angle	Pre	130.60	12.331	3.30	9.707	1.075	9	0.310	NS
	Post	127.30	10.563						
U1 to NA linear	Pre	4.30	3.743	-0.60	3.134	-0.605	9	0.560	NS
	Post	4.90	3.143						
L1 to NB linear	Pre	5.10	2.726	0.80	1.989	1.272	9	0.235	NS
	Post	4.30	3.434						
X axis to Mand Incisor	Pre	64.90	5.763	-3.30	3.802	-2.745	9	0.023	S
	Post	68.20	5.554						
X axis to Max Incisor	Pre	66.70	6.165	-3.10	2.331	-4.206	9	0.002	HS
	Post	69.80	5.493						
Y axis to Max Incisor	Pre	62.20	7.052	-2.25	2.680	-2.655	9	0.026	S
	Post	64.45	5.388						
Y axis to Mand Incisor	Pre	61.50	8.772	-0.70	4.762	-0.465	9	0.653	NS
	Post	62.20	4.872						
Y axis to Mand molar	Pre	32.70	5.499	-0.90	3.510	-0.811	9	0.438	NS
	Post	33.60	3.922						
Upper Molar to Palatal Plane	Pre	19.20	1.751	-0.75	1.654	-1.434	9	0.185	NS
	Post	19.95	1.536						
Over Jet	Pre	0.20	4.686	-1.80	5.095	-1.117	9	0.293	NS
	Post	2.00	1.414						
Overbite	Pre	-2.00	3.887	-3.70	3.368	-3.474	9	0.007	HS
	Post	1.70	1.703						
Total tissue profile angle	Pre	138.90	7.534	5.00	4.447	3.555	9	0.006	HS
	Post	133.90	7.340						

soft tissue profile angle	Pre	171.70	7.150	7.80	8.753	2.818	9	0.020	S
	Post	163.90	11.865						
Soft tissue Facial angle	Pre	89.60	3.373	0.10	2.961	0.107	9	0.917	NS
	Post	89.50	2.838						
Sup sulcus depth	Pre	3.65	1.292	0.35	1.055	1.049	9	0.322	NS
	Post	3.30	1.059						
Subnasale to H- line	Pre	5.75	1.752	-0.05	1.802	-0.088	9	0.932	NS
	Post	5.80	2.044						
Skeletal Profile Convexity	Pre	-0.70	1.783	-2.30	1.814	-4.011	9	0.003	HS
	Post	1.60	2.011						
Upper lip thickness	Pre	12.90	2.470	1.70	2.226	2.415	9	0.039	S
	Post	11.20	1.457						
Basic U lip thickness	Pre	12.80	2.860	-0.25	1.318	-0.600	9	0.563	NS
	Post	13.05	2.587						
H Angle	Pre	13.00	4.522	-2.80	2.300	-3.850	9	0.004	HS
	Post	15.80	4.733						
S-line to Upper Lip	Pre	1.25	2.045	-0.20	1.476	-0.429	9	0.678	NS
	Post	1.45	2.608						
S-Line to Lower Lip	Pre	5.30	2.908	1.50	0.850	5.582	9	0.000	HS
	Post	3.80	2.741						
E-line to Upper Lip	Pre	-1.55	3.403	-0.65	1.292	-1.591	9	0.146	NS
	Post	-0.90	3.510						
E-Line to Lower Lip	Pre	3.50	3.136	1.25	0.791	5.000	9	0.001	HS
	Post	2.25	3.012						

HS= Highly Significant (p<0.01), S= Significant (p<0.05), NS= Non Significant (p>0.05)

Table 6: Comparison of statistical evaluation between TTBA and Reverse Pull Head Gear groups in maxilla-mandibular relationship,size of maxilla, mandible and vertical relationship.

Variable	**Period**	**RP**		**TTBA**		**t-value**	**P-value**	**Significance**
		Mean	**Std.Dev.**	**Mean**	**Std.Dev.**			

ANB	Pretreat	-0.50	1.716	-1.10	1.220	0.901	0.379	NS
	Post treat	2.50	2.173	2.85	2.604	-0.326	0.748	NS
	Gain	3.00	2.108	3.95	3.261	-0.774	0.449	NS
Facial Convexity	Pretreat	1.00	5.518	-3.65	4.137	2.132	0.047	S
	Post treat	8.10	15.431	2.80	3.084	1.065	0.301	NS
	Gain	7.10	19.122	6.45	3.947	0.105	0.917	NS
Facial Angle	Pretreat	87.00	3.712	85.80	3.393	0.755	0.460	NS
	Post treat	86.60	2.171	86.05	2.733	0.498	0.624	NS
	Gain	-0.40	2.591	0.25	1.990	-0.629	0.537	NS
B⊥ to A⊥ (Occlusal)	Pretreat	-2.80	5.181	-4.75	2.189	1.096	0.287	NS
	Post treat	-0.65	2.539	-0.85	1.582	0.211	0.835	NS
	Gain	2.15	3.198	3.90	1.983	-1.471	0.159	NS
Angle SNA	Pretreat	78.50	2.635	77.70	3.917	0.536	0.599	NS
	Post treat	80.95	3.700	80.20	3.553	0.462	0.649	NS
	Gain	2.45	2.587	2.50	1.780	-0.050	0.960	NS
Maxillary length PNS-ANS	Pretreat	45.30	2.214	44.60	3.026	0.590	0.562	NS
	Post treat	47.65	2.001	48.25	2.841	-0.546	0.592	NS
	Gain	2.35	1.564	3.65	0.884	-2.288	0.034	S
Effective Maxillary	Pretreat	79.50	5.339	77.70	6.201	0.696	0.496	NS

Length	Post treat	82.85	4.042	81.20	5.549	0.760	0.457	NS
	Gain	3.35	2.729	3.50	1.000	-0.163	0.872	NS
Y axis to A	Pretreat	60.50	4.720	61.70	4.762	-0.566	0.578	NS
	Post treat	62.65	4.123	64.85	4.069	-1.201	0.245	NS
	Gain	2.15	1.564	3.15	1.733	-1.355	0.192	NS
A⊥ to N⊥ on FH	Pretreat	4.60	2.633	6.35	4.289	-1.100	0.286	NS
	Post treat	4.00	2.461	3.40	2.183	0.577	0.571	NS
	Gain	-0.60	2.787	-2.95	2.443	2.005	0.060	NS
SNB	Pretreat	79.00	3.559	78.80	3.111	0.134	0.895	NS
	Post treat	78.90	2.767	78.25	3.138	0.491	0.629	NS
	Gain	-0.10	1.595	-0.55	2.047	0.548	0.590	NS
Mandibular body lengt	Pretreat	72.20	5.846	68.00	4.497	1.801	0.089	NS
	Post treat	73.90	5.065	69.90	4.434	1.879	0.077	NS
	Gain	1.70	1.252	1.90	1.449	-0.330	0.745	NS
Effective Mand Length	Pretreat	102.20	9.175	96.10	5.782	1.779	0.092	NS
	Post treat	103.70	7.499	97.80	4.826	2.092	0.051	NS
	Gain	1.50	3.240	1.70	2.058	-0.165	0.871	NS
Y axis to B	Pretreat	55.10	7.172	58.75	6.228	-1.215	0.240	NS
	Post treat	54.00	6.110	58.30	5.458	-1.660	0.114	NS

	Gain	-1.10	2.961	-0.45	3.362	-0.459	0.652	NS
Y axis to Pog	Pretreat	55.40	8.113	59.10	5.990	-1.160	0.261	NS
	Post treat	54.30	7.349	58.90	5.405	-1.595	0.128	NS
	Gain	-1.10	2.998	-0.20	3.393	-0.629	0.538	NS
B⊥ to N⊥ on FH	Pretreat	6.93	5.570	9.25	5.731	-0.918	0.371	NS
	Post treat	8.35	4.631	7.65	4.720	0.335	0.742	NS
	Gain	1.42	4.376	-1.60	2.025	1.981	0.063	NS
SN-GoGn	Pretreat	32.20	4.367	27.70	3.917	2.426	0.026	S
	Post treat	33.10	6.855	27.80	3.327	2.200	0.041	S
	Gain	0.90	4.068	0.10	1.969	0.560	0.583	NS
FMA	Pretreat	28.90	4.095	24.70	3.498	2.466	0.024	S
	Post treat	30.40	5.719	25.00	3.712	2.505	0.022	S
	Gain	1.50	4.327	0.30	1.703	0.816	0.425	NS
FH to Palatal Plane	Pretreat	5.25	8.606	0.25	5.443	1.553	0.138	NS
	Post treat	7.50	13.024	1.35	4.035	1.426	0.171	NS
	Gain	2.25	5.818	1.10	5.734	0.445	0.662	NS
Facial Axis	Pretreat	90.20	4.517	90.20	3.824	0.000	1.000	NS
	Post treat	88.60	4.742	89.40	3.502	-0.429	0.673	NS
	Gain	-1.60	4.115	-0.80	2.700	-0.514	0.614	NS
X axis to ANS	Pretreat	41.50	4.428	40.20	3.765	0.707	0.489	NS

	Post treat	44.00	4.447	41.40	3.922	1.387	0.183	NS
	Gain	2.50	2.014	1.20	1.814	1.517	0.147	NS
X axis to PNS	Pretreat	38.90	4.434	37.75	5.760	0.500	0.623	NS
	Post treat	40.40	4.115	39.25	4.626	0.587	0.564	NS
	Gain	1.50	1.581	1.50	3.375	0.000	1.000	NS
X axis to Pog	Pretreat	95.60	7.662	92.70	6.255	0.927	0.366	NS
	Post treat	99.60	7.633	95.30	6.165	1.386	0.183	NS
	Gain	4.00	2.789	2.60	2.171	1.253	0.226	NS
LFH	Pretreat	66.90	3.755	63.50	5.039	1.711	0.104	NS
	Post treat	68.10	3.604	65.70	5.165	1.205	0.244	NS
	Gain	1.20	1.619	2.20	1.476	-1.443	0.166	NS

Table 7: Comparison of statistical evaluation between TTBA and Reverse Pull Head Gear groups in dentoalveolar and soft tissue changes

Variable	**Period**	**RP**		**TTBA**		**t-value**	**P-value**	**Significance**
		Mean	**Std.Dev.**	**Mean**	**Std.Dev.**			
U1 to SN	Pretreat	107.30	6.701	105.10	11.676	0.517	0.612	NS
	Post treat	111.10	8.198	107.10	10.290	0.961	0.349	NS
	Gain	3.80	8.728	2.00	8.446	0.469	0.645	NS
U1 to FH	Pretreat	113.20	5.865	112.20	12.182	0.234	0.818	NS
	Post treat	116.90	7.549	114.20	10.433	0.663	0.516	NS
	Gain	3.70	8.394	2.00	7.118	0.489	0.631	NS

L1 to MP	Pretreat	87.30	9.056	95.70	6.750	-2.352	0.030	S
	Post treat	86.60	10.658	93.80	6.339	-1.836	0.083	NS
	Gain	-0.70	4.138	-1.90	3.281	0.719	0.482	NS
L1 to FH	Pretreat	63.90	8.034	59.40	4.477	1.547	0.139	NS
	Post treat	63.50	6.754	60.90	4.677	1.001	0.330	NS
	Gain	-0.40	5.168	1.50	2.506	-1.046	0.309	NS
U1 to NA angular	Pretreat	27.10	6.903	26.90	9.723	0.053	0.958	NS
	Post treat	29.50	9.132	27.10	8.412	0.611	0.549	NS
	Gain	2.40	7.691	0.20	7.843	0.633	0.535	NS
L1 to NB angular	Pretreat	22.00	6.110	25.95	6.405	-1.411	0.175	NS
	Post treat	22.30	7.009	23.85	6.351	-0.518	0.611	NS
	Gain	0.30	5.056	-2.10	3.187	1.270	0.220	NS
Inter incisal angle	Pretreat	130.60	12.331	128.20	16.538	0.368	0.717	NS
	Post treat	127.30	10.563	127.70	13.969	-0.072	0.943	NS
	Gain	-3.30	9.707	-0.50	8.910	-0.672	0.510	NS
U1 to NA linear	Pretreat	4.30	3.743	4.75	2.486	-0.317	0.755	NS
	Post treat	4.90	3.143	3.70	2.869	0.892	0.384	NS
	Gain	0.60	3.134	-1.05	1.921	1.419	0.173	NS
L1 to NB linear	Pretreat	5.10	2.726	4.55	1.707	0.541	0.595	NS
	Post treat	4.30	3.434	3.80	1.735	0.411	0.686	NS

	Gain	-0.80	1.989	-0.75	0.825	-0.073	0.942	NS
X axis to Mand Incisor	Pretreat	64.90	5.763	64.00	4.922	0.376	0.712	NS
	Post treat	68.20	5.554	65.90	4.677	1.002	0.330	NS
	Gain	3.30	3.802	1.90	3.035	0.910	0.375	NS
X axis to Max Incisor	Pretreat	66.70	6.165	64.75	4.872	0.785	0.443	NS
	Post treat	69.80	5.493	66.70	4.739	1.351	0.193	NS
	Gain	3.10	2.331	1.95	2.166	1.143	0.268	NS
Y axis to Max Incisor	Pretreat	62.20	7.052	64.50	7.576	-0.703	0.491	NS
	Post treat	64.45	5.388	67.10	5.782	-1.060	0.303	NS
	Gain	2.25	2.680	2.60	3.978	-0.231	0.820	NS
Y axis to Mand Incisor	Pretreat	61.50	8.772	65.75	6.630	-1.222	0.237	NS
	Post treat	62.20	4.872	65.10	4.932	-1.323	0.202	NS
	Gain	0.70	4.762	-0.65	3.400	0.730	0.475	NS
Y axis to Mand molar	Pretreat	32.70	5.499	36.10	5.021	-1.444	0.166	NS
	Post treat	33.60	3.922	36.50	4.601	-1.517	0.147	NS
	Gain	0.90	3.510	0.40	2.914	0.347	0.733	NS
Upper Molar to Palatal Plane	Pretreat	19.20	1.751	20.00	5.598	-0.431	0.671	NS
	Post treat	19.95	1.536	19.45	3.989	0.370	0.716	NS
	Gain	0.75	1.654	-0.55	2.692	1.301	0.210	NS
Over Jet	Pretreat	0.20	4.686	-0.20	2.312	0.242	0.811	NS
	Post treat	2.00	1.414	2.00	1.764	0.000	1.000	NS

	Gain	1.80	5.095	2.20	2.690	-0.220	0.829	NS
Overbite	Pretreat	-2.00	3.887	-0.80	1.229	-0.931	0.364	NS
	Post treat	1.70	1.703	1.00	1.633	0.938	0.361	NS
	Gain	3.70	3.368	1.80	1.476	1.634	0.120	NS
Total tissue profile angle	Pretreat	138.90	7.534	137.10	8.774	0.492	0.629	NS
	Post treat	133.90	7.340	133.20	5.712	0.238	0.815	NS
	Gain	-5.00	4.447	-3.90	8.020	-0.379	0.709	NS
soft tissue profile angle	Pretreat	171.70	7.150	164.80	6.477	2.262	0.036	S
	Post treat	163.90	11.865	161.70	5.832	0.526	0.605	NS
	Gain	-7.80	8.753	-3.10	3.755	-1.560	0.136	NS
Soft tissue Facial angle	Pretreat	89.60	3.373	89.40	2.952	0.141	0.889	NS
	Post treat	89.50	2.838	89.30	3.498	0.140	0.890	NS
	Gain	-0.10	2.961	-0.10	2.378	0.000	1.000	NS
Superior sulcus depth	Pretreat	3.65	1.292	2.80	1.549	1.333	0.199	NS
	Post treat	3.30	1.059	2.90	1.126	0.818	0.424	NS
	Gain	-0.35	1.055	0.10	0.994	-0.981	0.339	NS
Subnasale to H-line	Pretreat	5.75	1.752	4.80	2.336	1.029	0.317	NS
	Post treat	5.80	2.044	5.75	2.348	0.051	0.960	NS
	Gain	0.05	1.802	0.95	1.878	-1.094	0.289	NS

Skeletal Profile Convexity	Pretreat	-0.70	1.783	-1.40	1.410	0.974	0.343	NS
	Post treat	1.60	2.011	1.05	1.301	0.726	0.477	NS
	Gain	2.30	1.814	2.45	0.762	-0.241	0.812	NS
Upper lip thickness	Pretreat	12.90	2.470	12.45	1.279	0.512	0.615	NS
	Post treat	11.20	1.457	13.05	1.802	-2.525	0.021	S
	Gain	-1.70	2.226	0.60	1.729	-2.581	0.019	S
Basic U lip thickness	Pretreat	12.80	2.860	13.75	1.990	-0.862	0.400	NS
	Post treat	13.05	2.587	12.80	1.751	0.253	0.803	NS
	Gain	0.25	1.318	-0.95	1.166	2.157	0.045	S
H Angle	Pretreat	13.00	4.522	13.40	4.789	-0.192	0.850	NS
	Post treat	15.80	4.733	16.00	3.742	-0.105	0.918	NS
	Gain	2.80	2.300	2.60	2.413	0.190	0.852	NS
S- line to Upper Lip	Pretreat	1.25	2.045	-0.15	1.901	1.586	0.130	NS
	Post treat	1.45	2.608	1.15	1.634	0.308	0.761	NS
	Gain	0.20	1.476	1.30	0.823	-2.059	0.054	NS
S- line to Lower Lip	Pretreat	5.30	2.908	2.95	2.266	2.016	0.059	NS
	Post treat	3.80	2.741	1.95	1.301	1.929	0.070	NS
	Gain	-1.50	0.850	-1.00	1.528	-0.905	0.378	NS
E- line to Upper Lip	Pretreat	-1.55	3.403	-1.55	3.883	0.000	1.000	NS
	Post treat	-0.90	3.510	-0.65	2.729	-0.178	0.861	NS

	Gain	0.65	1.292	0.90	1.524	-0.396	0.697	NS
E-line to Lower Lipe	Pretreat	3.50	3.136	1.85	2.625	1.276	0.218	NS
	Post treat	2.25	3.012	0.75	1.419	1.425	0.171	NS
	Gain	-1.25	0.791	-1.10	1.807	-0.240	0.813	NS

Discussion:

For treating any skeletal malocclusion, growth modification to correct the skeletal problem isthe ideal treatment for young patients. For improving the sagittal jaw relationship of a developing skeletal Class III malocclusion, the objective would be to stimulate maxillary growth, particularly when it is deficient, and to restrain mandibular growth, especially when it shows excessive growth. A literature review shows that in correcting the Class III malocclusion in young patients, the maxillary protraction appliance treatment results in a favourable change in a skeletal relationship by anterior displacement of the maxilla and redirection of mandibular position for which orthodontist requires utmost patient cooperation .

There are few alternatives in Class III treatment with intraoral appliances that can cause skeletal changes through neuromuscular modification. These include FR III, the Class III Bionator and the 2 Piece Corrector. TTBA is one such appliance that has been recently introduced for the treatment of growing Class III patients. During initial clinical use with this appliance, it was found to be more esthetic and comfortable than conventional devices because it can be worn intraorally. It is removable, making it easy for the patient to maintain better oral hygiene. Due to the paucity of scientific data on the effects produced by this appliance, the present prospective clinical study was planned to evaluate the skeletal dental and soft tissue changes produced by this appliance in growing Class III individuals.The present study was a prospective clinical study. Patients with a skeletal Class III malocclusion, negative overjet or at least edge-to-edge incisorrelationship and malar deficiency were included.All the patients were in early mixed or late mixed dentition, in accordance with the observation ofTakada et al[5]that both the prepubertal and mid-pubertal groups treated using the Reverse Pull Head Gear revealed more anterior displacement of the maxilla than was expected by natural growth.

Maxillary Protraction was carried out for a minimum of 6-8 months, till the positive overjet was achieved. A total of 24 hard and soft tissue parameters were used for the different linear and angular measurements. A single observation was analyzed using

more than one parameter to minimize the errors in interpretation. For example, a change in the sagittal skeletal relationship was assessed by analyzing angle ANB, Wits appraisal and angle of facial convexity instead of depending only on one measurement. A composite cephalometric analysis was done to determine the change in different variables.
For assessing the TTBA efficacy, the results obtained were compared with the results from a similar category of patients treated with RPH in our Department.Further, to evaluate its effects on growth, the results were compared with the data of untreated patients who were used as a control in a study by Macdonald et al.[6]

Interpretation of the results for Tandem Traction Bow Appliance Group
Changes in the Maxillo-Mandibular Relationship, size and position showed a statistically significant change ($p<0.01$), indicating that an overall skeletal change was favourable in correcting the sagittal maxillo-mandibular relationship. However, the facial angle did not show statistically significant change ($p>0.05$), indicating that the position of the chin remained unaltered.(Table 3).This implies that the TTBA had a positive influence on the forward growth of the maxilla. However change in the size and position of the mandible in the group of patients treated with TTBA showed non-significant changes ($p>0.05$) indicating appliance did not exert any gross effect on the mandible. The vertical skeletal proportions remained largely unaffected by the TTBA as the readings for S-N to Go-Gn, FMA, FH plane to palatal plane, Rickett's Facial axis, X axis to ANS and X axis to PNS did not show significant changes ($p>0.05$), whereas the value of X axis to Pog and the lower facial height showed significant changes ($p< 0.05$)(Table 2). The soft tissue profile angle significantly decreased ($p<0.05$), indicating that the TTBA improves the patient's profile from retrognathic to orthognathic (Table 3).The beneficial effect of treatment on the facial profile was accompanied by a highly significant increase ($p<0.01$) in the H- angle and skeletal profile convexity. A highly significant increase ($p<0.01$) in the upper lip to S-line distance showed that the upper lip moved anteriorly during treatment. Basic upper lip thickness significantly decreased ($p < 0.05$), indicating that point A moved forward during Tandem Traction Bow appliance treatment.
A positive correlation was found between the other hard and soft tissue measurements evaluated (r-value of -0.1165 for change in the angle of facial convexity and soft tissue profile angle), though the correlation was not statistically significant ($p>0.05$). This indicates that the change in the maxillo-mandibular hard tissue measurements brought about by the appliance causes a favourable change in the corresponding soft tissue measurements, though the two do not change to the same proportions.All other values for dentoalveolar changes showed non-significant changes ($p>0.05$).

Interpretation of results for Reverse Pull Head Gear group

Changes in the Maxillo-Mandibular Relationship, size and position showed a highly significant change ($p<0.01$), indicating that the overall skeletal change was favourable in correcting the sagittal maxillo-mandibular relationship. However, the angle of facial convexity, facial angle and B perpendicular to A perpendicular on occlusal did not show statistically significant change ($p>0.05$), indicating that the chin position remained unaltered during the RPH treatment phase indicating that the RPH has a positive influence on the forward growth of the maxilla where asthe RPHhad no marked effect on the mandibular growth.Changes in the vertical skeletal proportions showed no statistically significant changes ($p>0.05$) thereby implying that vertical proportion remains by and largely unaffected by RPHtherapy(Table 4). Soft tissue changes were significant with respect to the total tissue profile angle and the soft tissue profile angle, which showed a highly significant ($p<0.01$) and significant decrease ($p<0.05$),respectively(Table 5). Similarly, the H angle and skeletal profile convexity showed a highly significant increase ($p<0.01$), which improved the patient's soft tissue profile.The measurements of the S line and E line to the lower lip showed a highly significant decrease ($p < 0.01$), indicative of posterior movement of the lip to locate behind the S line.The upper lip thickness showed a significant decrease ($p<0.05$) due to the forward movement of upper incisors, which had a positive influence on improvement in the patient's profile.A positive correlation was found between the hard and soft tissue measurements evaluated in the maxillary area indicating that the change in the hard tissue measurements brought about by the appliance causes a favourable change in the corresponding soft tissue measurements, and both measurements change in the same proportion. With respect to dentoalveolar Changesmeasurements showed a significant increase ($p<0.05$), which is indicative of improvement from a negative overjet and overbite to a positive overjet and overbite.

Comparison between the effects of the Tandem Traction Bow Appliance and the Reverse Pull Head Gear

All the values that determine the maxillo-mandibular relationship showed no significant difference ($p>0.05$)(Table 6). This implies that the TTBA and RPH affected the sagittal skeletal relationship in a similar way. The comparison of two appliances for effects on the changes in size and position of the maxilla showed that there was a greater gain in the maxillary length in the TTBA treated group (3.6 mm) in comparison to the RPH group (2.3 mm) indicating that the TTBA had a more beneficial effect on the maxilla than the RPH where asthe comparison of changes in size and position of the mandible between

the TTBA and the RPH showed non-significant differences indicating that both these appliances had similar and minimal effects on the mandible. Both appliances had similar effects on the vertical relation. Hence, vertical relations remained more or less unaffected. With respect to dentoalveolar changes, though there was no significant difference between the two groups, the upper incisor to S-N and the upper incisor to FH plane measurements increased more in the RPHthan inthe TTBA group(Table 7). It suggests that there may be slightly more skeletal change than dentoalveolar change in the TTBA group.The lower incisor inclination was reduced during maxillary protraction in both groups. With respect to Soft Tissue Changes between the two groups, there were predominantly non-significant differences in soft tissue profile changes(Table 7). But the thickness of the upper lip showed significant improvement in the RPH group due to incisor proclination, which is indicative of a dentoalveolar change, whereas the basic upper lip thickness was improved in the TTBA group, which indicated a skeletal change. Thus, the TTBA brings about changes in the soft tissue profile more by skeletal changes than by dentoalveolar changes. In the measurement of the S line to upper lip value, the difference was significant between the two groups, and the gain was greater in the TTBA group.

Effects of the Tandem Traction Bow Appliance compared with the previous studies:

The results of our study are in concordance with the study by Toba et al on Turkish population which concluded that the both the appliances are effective in the treatment of midfacedeficiency.To our knowledge this is one of the first studies to report on the use of the TTBA for correction of Class III malocclusion in a sizeable group of patients (cleft and non-cleft) for the Indian Population although numerous studies were published that demonstrated the effectiveness of treatment modalities such as the RPH.

In terms of the skeletal sagittal relationship, the results of the present study are in agreement with those of Mcdonaldet al.[6] in which the angle ANB increased (3.9° in the present study and 3.3° in their study). Further, marginal differences are seen with respect to the maxillary position. In both studies, there was a favourable improvement in the maxillary position.The effects of the TTBA were minimal concerning the mandibular plane angle (FMA increased with 0.3°) which is in contrast to the higher value reported in the literature.

For soft tissue changes, those obtained by TTBA correlate with those of Attlah[7] who reported a statistically significant increase in the convexity of the soft tissue profile in Class III patients treated using Face Mask therapy. Changes in size and position of the mandible results shown by the TTBA and the RPH in the present study are in accordance

with those reported by Saadia and Torress[8]. The results of our study are in not in concordance with the study done by Tobi et al [9] on Turkish population which concluded that the ANB angle showed a significantly greater increase in the FM group (2.8 ± 0.30°) than in the MTTBA group (2.0 ± 0.18°). The overjet and molar relation increased significantly in both treatment groups, but in the FM group showed statistically significant increase in overjet than in the MTTBA group . Mesial movement of upper molar and incisor were found to be greater in the FM group compared to the modified TTBA group.

Effects of the tandem traction bow appliance in the modulation of growth changes

For the purpose of comparison between untreated Class III patients and presentTTBA treated patients, the study byMacdonald et al·[6]is used which compared the patients treated using face mask therapy with untreated patients. They found significant improvements in the angle SNA (2.3°), Wits (2.75mm) and the angle of facial convexity (2.87°), which indicated significant advancement in the maxillary structure, thus inducing more patient growth in treated individuals than controls.

In the present study, the effects of TTBA were at par or even better than RPH. From this,it can be hypothesised that TTBA would significantly affect the growth pattern of Class III individuals in comparison to untreated individuals.

Clinical implications:

The TTBA is an effective, efficient semi-fixed functional appliance.It can be used effectively in the treatment of growing skeletal Class III malocclusions whose Class III is on account of mid-facial deficiency.As most of the changes brought about by the appliance are skeletal, it is more appropriate to use this appliance in those Class III patients whose problem is on account of skeletal discrepancy rather than dentoalveolar discrepancy.As this appliance is intraoral in nature, it has the advantage of beingmore esthetic, thereby improving patient compliance, which is one of the most important considerations in any treatment.Another valuable aspect of the TTBA is the incorporation of a rapid palatal expander device simultaneously.As is seen in skeletal Class III malocclusion, the maxillary growth is often deficient in all three planes i.e. sagittal, vertical and transverse. Rapid palatal expander which can be incorporated into the TTBA helps in the transverse dimensional improvement of the Maxilla.

Conclusions:

According to the current prospective study the following conclusions can be drawn;

- Skeletal changes were primarily a result of the anterior movement of the maxilla. After maxillary protraction, statistically significant anterior movement of the maxilla and

decrease in the proclination of the upper and lower inciosrs occurred without any changes in the mandible and vertical relation.

- The overjet and overbite were significantly improved by a mean value of 2.2 mm and 1.8 mm).
- Changes in hard tissue and dentoalveolar were reflected in the soft tissue profile
- Class III concave profile became more balanced, with the upper lip area becoming more marked.
- No distinct differences were present between the Tandem Traction Bow Appliance group and the Reverse Pull Head Gear group except for the Maxillary length. There was a significant gain in Maxillary length in the TTBA group (3.6 mm) with respect to the Reverse Pull Head Gear (2.3 mm).
- In comparison with the control group, the maxillary length, angle SNA and the angle of facial convexity increased in the patients treated with Tandem Traction Bow Appliance.

TTBA and RPH , both were found to be effective in the correction of deficient maxilla. However, TTBA is effective in sagittal and dentoalveolar correction of the midface deficiency compared to RPH and control group.

Limitations of the Study:

1. The greatest limitation of our study was the absence of an age and gender matched control group of our own population. Unfortunately, this limitation is difficult to overcome, since some subjects to be used as controls will have to be deprived of timely functional / orthopaedic correction, which is ethically incorrect.
2. The study sample size was small as only 10 patients who met the selection criteria became available within the time frame. Hence, the results obtained from the current study will have to be confirmed using a larger sample.
3. The occurrence of maxillary hypoplasia in individuals can occur on two accounts, due to genetic predisposition and also due to iatrogenic factors such as seen in the case of surgically treated cleft patients. Hence, to evaluate the effects of the Tandem Traction Bow Appliance and the Reverse Pull Head gear on the above mentioned accounts we included two cleft patient in the study group. However, this introduced a small amount of lack of homogeneity in the sample.
4. There was no uniform distribution between the male and female subjects. Hence, gender based comparison could not be carried out.
5. It was a short-term study and hence the stability of the results needs to be established by continuing the study.

6. As the results obtained from the appliance are patient compliance dependent, there was no method by which we could monitor the compliance level of all the patients, which could have affected the end results for comparison.

Conflicts of interest: The authors declare that they donot have conflicts of interest.
Funding: The paper donot have any source of funding.
Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Address:
[1]MDS,Private practice, Dr.Ritu's orthodontic and dental care, Udaipur, Rajasthan, India
[2]MDS,Assistant Professor, Department of Orthodontics and Dentofacial Orthopedics, SDM College of Dental Sciences and Hospital, A Constituent Unit of Sri Dharmasthala Manjunatheshwara University, Dharwad, Karnataka, India.
[3]MDS,Additional Professor, Department of Orthodontics and Dentofacial Orthopedics, SDM college of Dental Sciences and Hospital, A Constituent Unit of Sri Dharmasthala Manjunatheshwara University, Dharwad, Karnataka, India.
[4]MDS,Private Practice and Former HOD, Department of Orthodontics and Dentofacial Orthopedics, SDM College of Dental Sciences and Hospital, Dharwad, Karnataka, India

References

[1] Chun YS, Jeong SG. A New Appliance for Orthopedic Correction of Class III malocclusion. J ClinOthod 1999; 33: 705 – 711.
[2] Klempner LS.Early Orthopedic Class III Treatmentwith a Modified Tandem Appliance J ClinOthod 2003; 37: 705 – 711.
[3] Jacobson A. Radiographic cephalometry – from basic to video imaging Illions; Quintessence Publishing Co. Inc. 1995; Page 53.
[4] Rakosi T. An Atlas and Manual of Cephalometric Radiography. London; Wolfe Medical Publications Ltd. 1982; Page 35-37.
[5] Takada K, Petachai S, Sakuda M. Changes in dentofacial morphology in skeletal Class III children treated by a modified maxillary protraction head gear and chincup: a longitudinal cephalometric appraisal. Eur J Orthod 1993; 15: 211-21.
[6] Macdonald KE, Kapust AJ, Turley P. Cephalometric changes after the correction of Class III malocclusion with maxillary expansion / facemask therapy. Am J Orthod Dentofac Orthop 1999; 116: 13-24.
[7] Atallah K. Evaluation du changement du profile cutane après traitement des classes III par masque de Delaire. These 2 eme cycle. Clermont-Feerrand: Univ. Clermont-Ferrand, 1981, Page 1-92.

[8] Saadia M, Torres E. Sagittal changes after maxillary protraction with expansion in Class III patients in the primary, mixed and late mixed dentitions: a longitudinal retrospective study. Am J OrthodDentofacialOrthop 2000; 117: 669-80.

[9] Tuba Tortopa ; EmineKaygısızb ; DenizGencerc ; SemaYuksela ; ZeynepAtalayd Modified tandem traction bow appliance compared with facemask therapy in treating Class III malocclusions.Angle Orthod. 2014;84:642–648.