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Research Article

A CORRELATION OF CONDYLAR INCLINATION WITH DENTOSKELETAL CHANGES IN CLASS II DIVISION I PATIENTS FOLLOWING TWIN BLOCK, FIXED FUNCTIONAL APPLIANCE THERAPY AND CAMOUFLAGE

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A B S T R A C T

The class II malocclusion which is one of the most common skeletal malocclusions can be treated by a variety of treatment modalities includingsimple functional appliances, orthodontic camouflage to the more complex surgical intervention.The degree of dentoskeletal change brought by each modality varies and its implications on condylar inclination is vital and needed to be better understood.

Aims: Evaluation and comparison of the dentoskeletal changes achieved by twin block, fixed functional appliances and camouflage therapy in Class II Division I patients and its co-relation with changes in condylar inclination.

Material and Methods: The experimental sample consisted of 45 consecutively treated patients who were equally divided into camouflage, twin block and fixed functional groups. Lateral cephalograms were evaluated for 22 parameters (18 skeletal, 4 dental) at T1 (Pre-treatment); T3 (completion of fixed appliance therapy) for the three groups and at T2 (post functional therapy) for the twin block and fixed functional group. The majority of the cephalometric variables were normally distributed according to Shapiro-Wilk test and hence the differences between the groups were evaluated using parametric tests (paired t test). The significance for all tests was predetermined as $P < 0.05$.

Results: The amount of forward repositioning of the mandible was significantly higher by twin block therapy which also caused a greater opening of the mandibular plane angle compared to the other forms of therapy. The nasolabial angle at the end of therapy significantly differed between the fixed functional and the twin block group. The condylar inclination did not show significant difference in change between the groups before and after therapy.

INTRODUCTION

The true nature of a malocclusion cannot be completely understood without information about the underlying skeletal relationships, which can be adequately detailed by the use of a cephalogram. It supplements rather than supplants a careful clinical evaluation of the patient since it is merely a static two dimensional representation of the hard tissues involved in a complex three dimensional system.[1]

The disharmony between the sizes of the jaws plays a vital role in the development of a skeletal class II malocclusion which is one of the most commonly presenting skeletal malrelation of the jaw bases in orthodontics characterized by mandibular retrusion. It can also be due to a maxillary skeletal excess, the underlying cause of which can be definitely understood cephalometrically using the McNamara's analysis[2].

The timing of actively treating a Class II skeletal malocclusion has been subject to much debate due to the underlying uncertainties in the effects and stability of such an early treatment. Many treatment approaches available today include a variety of extraoral traction appliances, arch expansion mechanism, extraction procedures, functional jaw orthopedic appliances and surgical intervention.[3] Studies to evaluate the effects of an early orthopedic treatment by hyperpropulsion of the mandible in young rat condylar cartilage, have shown that growth occurs mainly by mitoses of the young cells in the prechondroblastic zone and to a minor degree by mitoses of the differentiated cells of the chondroblastic zone.[4] Early treatment however, has been said to the weigh the patient in terms of attendances and duration of appliance wear.[5]

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The maxilla and mandible articulate with the different areas of the cranial base, hence variations in growth and orientation of the cranial base region can lead to differential positioning of the maxilla and mandible causing changes in glenoid fossa and inclination of the condylar head in it.[6]

The present study was designed to evaluate and compare the dentoskeletal changes achieved with treatment using twin block, fixed functional appliances and camouflage therapy in Class II division I patients in cervical vertebrae maturation stages 3,4 and to correlate it with changes in condylar inclination in the Dharwad population.

Aims and Objectives

Evaluation and comparison of the dentoskeletal changes achieved by twin block, fixed functional appliances and camouflage therapy in Class II Division I patients and its correlation with changes in condylar inclination.

MATERIALS AND METHODS

Sample Selection

The study sample consisted of 60 lateral cephalograms of patients with skeletal Class II relation who had successfully completed treatment in the Department of Orthodontics and Dentofacial Orthopaedics at our institution. The patients were divided equally and randomly among the camouflage (Group 1), twin block (Group 2) and fixed functional (Forsus FRD; Group 3) groups. Although there appeared to be a discrepancy between chronologic ages in the sample, they were all matched carefully for growth stages by cervical vertebrae maturation (CVM) evaluation.

Lateral cephalograms were taken for the treated groups at T_1 (initial records), T_2 (completion of functional therapy), T_3 (completion of fixed appliance therapy).

The Inclusion Criteria were as Follows

1. Class II division I malocclusion with mandibular retrusion.
2. CVM between stage 3 and 4 at initial records.
3. Landmarks were identifiable on all the radiographs.
4. The treatment of functional appliance therapy was not combined with a headgear.

All the patients with twin block had the appliance until the completion of the mixed dentition period after which the second phase of fixed appliance treatment commenced. The lateral cephalograms of the camouflage group were matched to the functional groups at T1 and T3 by cervical vertebrae maturation and comparisons of treatment outcomes were made.

In this retrospective investigation the treatment groups were solely based on their Class II skeletal and dental features and not upon their treatment responses. The camouflage group was selected based on class II skeletal and dental features and progression of growth.

The list of research tools used were a 0.3mm Staedtler Mars micro pencil, 0.3 mm 2B pilot lead, ruler, protractors, eraser, 3M scotch tape, acetate sheets and 0.5 mm Flair multicoloured pen. The cephalograms were traced manually by a single investigator to avoid variations in landmark identification and measurements.

Cephalometric Analysis

Lateral cephalogram of each subject was taken with KODAK 9000C extraoral imaging. All subjects were positioned in the cephalostat with the mid-sagittal plane at a right angle to the path of the X-rays, the Frankfort plane parallel to the horizontal, the teeth in centric occlusion and the lips slightly parted. The linear, angular and soft tissue measurements were then made (Figure 1 and 2).

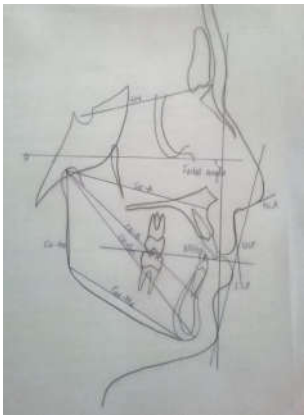

Figure 1 Linear and soft tissue measurements

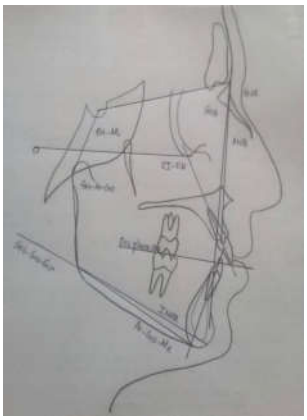

Figure 2 Angular measurements

Statistical Analysis

The mean was estimated for each cephalometric variable in each group. The majority of the cephalometric variables were normally distributed according to Shapiro-Wilk test and hence the differences between the groups were evaluated using parametric tests (paired t-test). The significance for all tests was predetermined as $P < 0.05$.

RESULTS

Comparison of Starting Forms

The groups showed no statistically significant differences in the skeletal and soft tissue parameters included in the study at T_1.

Comparison of Treatment Effects

Comparison between various groups showed no statistically significant differences between the groups associated with growth during the intervals of time included in the study.

The amount of forward repositioning of the mandible was significantly higher by twin block therapy, intermediate by the fixed functional appliance and negligible in the camouflage group which in effect could be said to account for difference in the ANB between the groups. Twin block therapy also caused a greater opening of the mandibular plane angle compared to the other forms of therapy studied here, also, the nasolabial angle at the end of therapy significantly differed between the fixed functional and the twin block group which may be accounted for by the head gear like effect produced by the fixed functional appliances. Saddle angle (N-S-Ar) and Articular angle (S-Ar-Go) which are suggestive of the condylar inclination did not show significant difference in change between the groups before and after therapy.

Table I Comparison of dentoskeletal changes before treatment (T1) and after treatment (T3) with respect to different parameters in group 1 by paired t-test.

Parameters	Mean Difference (T3-T1)	SD Difference	% of change	Paired t- test	P-value
Ar-Go-Me	-0.90	2.51	-0.7	-1.1319	0.2869
SN-Ar	-0.90	1.91	-2.31	-1.4886	0.1708
IMPA	3.70	7.79	3.71	1.5021	0.1673
U1-FH	9.52	13.73	8.44	2.1881	0.0564
SNA	-0.10	2.13	-0.12	-0.1483	0.8853
SNB	-0.90	2.02	-1.2	-1.4056	0.1934
ANB	1.00	1.15	16.13	2.7386	0.1229
0cc Plane-SN	0.50	5.72	2.96	0.2764	0.7885
SN-N-Pog	-0.10	1.79	-0.13	-0.1765	0.8638
SN-Go-Gn	-2.30	1.77	-7.21	-4.1162	0.0026*
Co-Go	-2.60	2.72	-4.75	-3.027	0.1143
Co-A	-2.20	1.32	-2.56	-5.2842	0.1005
Co-Gn	-3.10	2.51	-3.16	-3.8988	0.1036
Co-B	-3.30	2.58	-4.91	-4.0383	0.2029
Go-Me	-1.90	3.07	-2.97	-1.9562	0.0821
Witts	2.90	2.92	43.28	3.1373	0.0120*
N-S-Ar	1.70	1.34	36.17	4.0194	0.403
S-Ar-Go	0.40	3.47	5.48	0.3645	0.7239
LLL,mm	-0.20	0.92	-0.46	-0.6882	0.5086
ULL,mm	0.00	1.25	0.00	0.000	1.0000
NLA,degrees	-6.90	9.60	-7.24	-2.2736	0.0491*
Facial angle	-0.30	2.67	-0.36	-0.3555	0.7304

*p<0.05

Table 4 Comparison of group 1 and group 2 with respect to changes from T3-T1 by paired t-test

Parameters	Group 1		Group 2		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Ar-Go-Me	0.90	2.51	4.40	5.34	-1.8759	0.0770
SN-Ar	0.90	1.91	-2.70	1.36	4.8542	0.0001*
IMPA	-3.70	7.79	3.10	6.90	-2.0660	0.0535
U1-FH	9.50	13.73	5.20	8.38	0.8455	0.4090
SNA	-0.10	2.13	1.00	3.71	-0.8127	0.4270
SNB	-0.90	2.02	-2.50	3.95	1.1396	0.2694
ANB	1.00	1.15	3.30	1.57	-3.7366	0.0015*
0cc Plane-SN	0.50	5.72	-0.80	2.15	0.6727	0.5097
SN-N-Pog	-0.10	1.79	-1.70	2.79	1.5255	0.1445
SN-Go-Gn	2.30	1.77	2.00	2.21	0.3352	0.7414
Co-Go	2.60	2.72	3.00	1.76	-0.3906	0.7007
Co-A	2.20	1.32	2.60	1.07	-0.7442	0.4664
Co-Gn	3.10	2.51	5.50	3.92	-1.6288	0.1207
Co-B	3.30	2.58	5.00	3.53	-1.2294	0.2348
Go-Me	1.90	3.07	3.90	2.56	-1.5822	0.1310
Witts	2.90	2.92	3.55	1.76	-0.6029	0.5541
N-S-Ar	1.70	1.34	2.70	1.55	-1.5451	0.1397
S-Ar-Go	-0.40	3.47	0.61	1.67	-0.8296	0.4176
LLP,mm	0.20	0.92	3.10	1.85	-4.4339	0.0003*
ULP,mm	0.00	1.25	2.00	2.31	-2.4097	0.0269*
NLA,degrees	6.90	9.60	15.70	18.06	-1.3606	0.1904
Facial angle, degrees	0.30	2.67	1.10	2.02	-0.7552	0.4599

Table 5 Comparison of group 1 and group 3 with respect to changes from T3-T1 by paired t-test

Parameters	Group 1		Group 3		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Ar-Go-Me	0.90	2.51	8.70	8.96	-2.6512	0.0162*
SN-Ar	0.90	1.91	-2.50	2.94	3.0629	0.0067*
IMPA	-3.70	7.79	-1.80	9.54	-0.4877	0.6316
U1-FH	9.50	13.73	8.00	6.39	0.3132	0.7577
SNA	-0.10	2.13	0.00	2.31	-0.1006	0.9210
SNB	-0.90	2.02	-3.50	2.32	2.6691	0.0156*
ANB	1.00	1.15	3.50	1.08	-5.0000	0.0001*
0cc Plane-SN	0.50	5.72	-0.90	2.56	0.7065	0.4889
SN-N-Pog	-0.10	1.79	-1.60	4.55	0.9698	0.3450
SN-Go-Gn	2.30	1.77	3.90	3.57	-1.2693	0.2205
Co-Go	2.60	2.72	2.00	1.63	0.5987	0.5569
Co-A	2.20	1.32	2.80	3.88	-0.4629	0.6490
Co-Gn	3.10	2.51	7.60	5.54	-2.3384	0.0311*
Co-B	3.30	2.58	4.60	5.70	-0.6569	0.5196
Go-Me	1.90	3.07	5.40	2.59	-2.7546	0.0130*
Witts	2.90	2.92	0.35	2.98	1.9311	0.0694
N-S-Ar	1.70	1.34	2.05	0.90	-0.6875	0.5005
S-Ar-Go	-0.40	3.47	1.25	1.40	-1.3944	0.1802
LLP,mm	0.20	0.92	3.00	2.62	-3.1840	0.0051*
ULP,mm	0.00	1.25	3.50	2.80	-3.6121	0.0020*
NLA,degrees	6.90	9.60	16.30	7.51	-2.4388	0.0253*
Facial angle, degrees	0.30	2.67	0.90	3.31	-0.4458	0.6610

*p<0.05

Table 6 Comparison of group 2 and group 3 with respect to changes from T2-T1 and T3-T1 by paired t-test

Parameters	Changes	Group 2		Group 3		t-value	p-value
		Mean	S.D.	Mean	S.D.		
Ar-Go-Me	T2-T1	4.10	4.31	4.50	1.51	-0.2772	0.7848
	T3-T1	4.40	5.34	8.70	8.96	-1.3041	0.2086
SN-Ar	T2-T1	-1.90	1.45	-2.80	1.75	1.2521	0.2266
	T3-T1	-2.70	1.36	-2.50	2.94	-0.1951	0.8475
IMPA	T2-T1	2.00	4.27	3.80	2.25	-1.1795	0.2536
	T3-T1	3.10	6.90	-1.80	9.54	1.3156	0.2048
U1-FH	T2-T1	4.70	5.91	4.30	3.37	0.1860	0.8545
	T3-T1	5.20	8.38	8.00	6.39	-0.8402	0.4118
SNA	T2-T1	1.00	2.98	-0.30	1.49	1.2327	0.2336
	T3-T1	1.00	3.71	0.00	2.31	0.7234	0.4788
SNB	T2-T1	-2.10	3.38	-3.40	1.65	1.0931	0.2888
	T3-T1	-2.50	3.95	-3.50	2.32	0.6901	0.4990
ANB	T2-T1	3.10	1.29	3.10	1.20	0.0000	1.0000
	T3-T1	3.30	1.57	3.50	1.08	-0.3323	0.7435
0cc Plane-SN	T2-T1	-1.20	1.87	-1.50	1.96	0.3501	0.7304
	T3-T1	-0.80	2.15	-0.90	2.56	0.0946	0.9257
SN-N-Pog	T2-T1	-0.10	1.85	0.10	2.60	-0.1980	0.8452
	T3-T1	-1.70	2.79	-1.60	4.55	-0.0592	0.9534
SN-Go-Gn	T2-T1	1.80	1.69	2.10	1.66	-0.4005	0.6935
	T3-T1	2.00	2.21	3.90	3.57	-1.4299	0.1699
Co-Go	T2-T1	2.90	1.79	1.30	0.95	2.4954	0.0225*
	T3-T1	3.00	1.76	2.00	1.63	1.3156	0.2048
Co-A	T2-T1	2.10	1.52	-1.20	4.21	2.3302	0.0316
	T3-T1	2.60	1.07	2.80	3.88	-0.1570	0.8770
Co-Gn	T2-T1	4.20	3.77	4.90	3.98	-0.4038	0.6911
	T3-T1	5.50	3.92	7.60	5.54	-0.9781	0.3410
Co-B	T2-T1	3.70	4.24	1.20	4.29	1.3102	0.2066
	T3-T1	5.00	3.53	4.60	5.70	0.1887	0.8524
Go-Me	T2-T1	3.10	3.14	2.70	3.37	0.2746	0.7868
	T3-T1	3.90	2.56	5.40	2.59	-1.3028	0.2091
Witts	T2-T1	1.50	2.92	-0.50	1.58	1.9021	0.0733
	T3-T1	3.55	1.76	0.35	2.98	2.9246	0.0091*
N-S-Ar	T2-T1	1.35	2.31	2.40	1.17	-1.2815	0.2163
	T3-T1	2.70	1.55	2.05	0.90	1.1486	0.2658
S-Ar-Go	T2-T1	1.86	2.35	1.25	1.23	0.7268	0.4767
	T3-T1	0.61	1.67	1.25	1.40	-0.9301	0.3646
LLL,mm	T2-T1	3.10	2.38	1.90	2.33	1.1396	0.2694
	T3-T1	3.10	1.85	3.00	2.62	0.0984	0.9227
ULL,mm	T2-T1	1.00	1.41	1.20	1.40	-0.3180	0.7541
	T3-T1	2.00	2.31	3.50	2.80	-1.3072	0.2076
NLA,degrees	T2-T1	8.70	14.29	9.90	5.78	-0.2461	0.8084
	T3-T1	15.70	18.06	16.30	7.51	-0.0970	0.9238
Facial angle, degrees	T2-T1	1.30	2.16	0.40	3.66	0.6698	0.5115
	T3-T1	1.10	2.02	0.90	3.31	0.1628	0.8725

*p<0.05

DISCUSSION

The study retrospectively compared the amount of dentoskeletal and soft tissue changes achieved with treatment by using twin block, fixed functional appliances and camouflage therapy in Class II Division I patients using cervical vertebrae maturation stages 3, 4 and correlated it with changes in condylar inclination if any.

The Camouflage Group

The Sn-Go-Gn was increased significantly compared to the pre-treatment values which could be due to extrusion of the buccal teeth due to the effect of class II elastics. The Witts appraisal also showed a significant change post treatment. The retraction of the incisors following therapy could have led to changes in the A point and hence significant changes in the value. The nasolabial angle increased post treatment possibly by the retrusion of the upper anteriors following extraction of the first premolars, which are in agreement with the findings of Kinzinger *et al*[7] and Basciftici and Usumez.[8] (Table I).

The Twin Block Group

The mandibular plane angle increased significantly in the twin block group which could be due to the growth of the posterior mandibular alveolar processes and eruption of buccal teeth leading to a clockwise rotation of the mandible. Similar findings have been reported by Tümer and Gültan [9]and Bacetti *et al* [10], however they have been in complete contrast to studies by Siara-Olds *et al*[6] who reported a decrease in the angle due to the bite block effect of the twin block.

The mandibular unit length measured from Co-Gn increased post treatment in the twin block group which was corroborated with an increase in the mandibular body length as well. Similar findings have been reported by Mills and McCulloch [11], Baccetti *et al* [10] and Trenouth *et al* [12].
The length of the maxilla was restricted corresponding to previous studies by Siara-Olds *et al*. Also, the Witts appraisal value decreased following treatment thereby demonstrating a stability of the treatment results obtained. [6]
The condylar inclination did not show any significant changes post treatment in our study which could be due to the fact that the patients had begun the therapy relatively early. Baccetti *et al* [10] have found similar results in which they stated that forward repositioning of the mandible was greater in the patients receiving treatment earlier and adaptations in the amount and direction of condylar growth occurred in patients receiving treatment later (Table II).

The Forsus FRD group

The mandibular body length increased significantly post treatment which was in agreement with studies on the Herbst and functional manbibular advancer though not in agreement with studies by Aras *et al* [13]. This could be attributed to the younger mean age of the subjects in their sample though they had similar findings in the peak pubertal time period.

The study showed anterior relocation of point B and Pogonion which may have in effect contributed to the increase in SNB as also a decrease in the ANB angle which was comparable to the findings of Aras *et al* [13]. They also found no clear differences in the annual growth rates for adolescents pertaining to Co-Go and Co-Gn in contrast to our study. The Sn-Go-Gn value was higher at the end of the treatment in our study possibly due to the clockwise rotation of the mandible which is in contrast to the findings by Aras *et al* who found that the angle was maintained or even reduced post therapy [13].

The Sn-Ar value reduced significantly suggesting anterior repositioning of the mandible. Similar findings have been reported by Illing *et al* [14] but these have been in contrast to results obtained by Aras at el [13] who found no changes in the position of the mandible through magnetic resonance imaging studies. The maxillary incisors retroclined significantly at the end of therapy probably due to the head gear like effect of these appliances which has also been noted by Nelson *et al* [15] in their study (Table III).

Comparison Between the Groups

The mandibular forward repositioning and reduction in the ANB value was highest in the twin block group followed by the fixed functional and least in the camouflage group. The change in ramal height measured from Co-Go was more in T_{1-2} interval and was relatively higher in the twin block group. The Witts appraisal value reduced significantly in the T_{3-2} time period and a higher reduction was seen in the twin block group and was similar in the camouflage and fixed functional group (Table IV-VI).

CONCLUSIONS

The amount of dentoskeletal changes produced by the three modalities of therapy differ significantly from each other with more skeletal changes in the twin block group followed by the fixed functional group than the camouflage group provided treatment is begun at the appropriate age. The condylar inclination however has not been found to vary significantly between the groups suggestive of control by intrinsic factors of growth. However with advances in technology we may be able to accurately delineate the factors influencing this phenomenon in the near future.

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