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Original Research Article

Evaluation of clinical effects of Advansync™ 2 fixed functional appliance in skeletal Class II malocclusion: A retrospective cephalometric study

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ABSTRACT

Objectives: To evaluate the treatment effects of AdvancSync 2 TM in patients of skeletal Class II malocclusion in selected skeletal, dental, soft tissue and airway parameters.

Materials and Methods: Pretreatment and post-functional lateral cephalograms of 12 patients (06 males and 06 females with mean age of 14.25+0.75) with skeletal Class II malocclusion treated using AdvanSync 2 TM were evaluated. Paired t-test and Wilcoxon rank-sum intraclass correlation (ICC) test results were calculated.

Results: Statistically significant changes were found in skeletal parameters of SNB, Wits, maxillo-mandibular differential, Björk's sum, basal plane angle, Sn-GoGn, lower anterior facial height (LAFH), Na-perp-Pog. Changes in dental parameters U1-NA (angular and linear), L1 to NB (angular and linear), U1-SN angle, IMPA, Inter-incisal angle, L1 to A-Pog and U1 to A-Pog were also observed to be statistically significant at T1. Soft tissue skeletal convexity and nasolabial angle improved significantly post treatment, while, statistically significant change was observed only in posterior pharyngeal airway space among the chosen cephalometric airway parameters.

Conclusion: Treatment with AdvanSync™ 2 corrected the Class II malocclusion by producing skeletal and dentoalveolar changes. Soft tissue facial convexity and nasolabial angle improved with treatment. Further, linear dimension of the posterior pharyngeal airway space showed significant improvement with AdvanSync 2™ therapy.

1. Introduction

Class II malocclusion being a common maxillo-mandibular skeletal discrepancy, has been reported in 23% children, 15% youths and 13% adults.[1,2] It manifests as maxillary prognathism, mandibular retrognathism, or a combination of both.[3] Removable functional appliances like the Activator, Bionator and Twin Block, though effective are dependent upon patient compliance for clinical success. However, Fixed functional appliances (FFAs) being non-compliant Class II correctors, do not depend upon patient compliance for a favourable treatment outcome. AdvanSync™ FFA was introduced in 2008 and later upgraded to the AdvanSync 2™ FFA (Ormco Corporation) in 2012 which is reported to produce greater skeletal changes than its contemporaries.[4–6]

AdvanSync™ 2, developed by Terry and Bill Dischinger, is a rigid fixed tooth-borne functional appliance. The appliance consists of crowns cemented on the maxillary and mandibular first permanent molars with interconnecting telescopic rods that posture the mandible forward to promote mandibular growth at the condylar region.[6] In

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addition to enhancing mandibular growth, AdvanSync™ 2 is also reported to restrain further maxillary growth, hence producing a 'headgear effect'.[7]

Though literature is replete with evidences in favour of FFAs,[8–10] this study was conducted to provide comprehensive data on the skeletal, dental, soft-tissue and airway changes produced by AdvanSync™ 2 appliance in correction of skeletal Class II malocclusion.

The null hypothesis for the study was 'There are no changes in skeletal, dental, soft-tissue and airway parameters following treatment of skeletal Class II malocclusion with AdvanSync™ 2 fixed functional appliance.

1.1. Sample size calculation

The sample size for the study was calculated based on the formula described by Pandis with a 95% level of significance and 80% power.[11] The sample size obtained to test the null hypothesis was 12. The sample characteristics are depicted in Table 1.

2. Materials and Methods

This retrospective study was conducted in the department of Orthodontics and Dentofacial Orthopedics of a tertiary care government dental establishment following ethical clearance obtained by the institutional ethical committee. The inclusion criteria comprised of patients diagnosed with skeletal Class II malocclusion due to mandibular retrognathism. Cases with complete pre-functional and post-functional records, permanent dentition with symmetric Class II molar relation bilaterally, an overjet >5mm, a positive Visual Treatment Objective (VTO) indicating functional appliance therapy and treated with AdvanSync™ 2 fixed functional appliance were chosen to be included in the study sample. Exclusion criteria comprised of patients with history of previous orthodontic treatment/ trauma/ systemic disorders affecting the bone metabolism. Patients with neuromuscular disorders/ TMJ pathology, syndromes including cleft lip and palate and skeletal asymmetry were excluded.

Based on the set inclusion and exclusion criteria, pre-treatment records (T0) of 12 patients were taken from the departmental archives. A representative case is shown in Figure 1. This study aimed to analyse the effects of the AdvanSync™ 2 (Ormco AdvanSync™ II) independent of a fixed preadjusted edgewise appliance. This method of application was derived from Ghaffar et al who similarly compared the dentoskeletal efficacy of the AdvanSync™ 2 to another functional appliance.[12] The functional phase lasted for 6-8 months until unrestrained Class I molar and canine relation was observed along with optimum facial esthetics. At this stage, post-functional records (T1) were taken and the AdvanSync™ 2 appliance was removed. Following functional phase, the patients underwent fixed orthodontic treatment using a 0.022" MBT pre-adjusted edgewise appliance. The dentition was leveled and aligned using standard archwire sequence followed by settling of the occlusion.

The pre-functional and immediate post-functional lateral cephalograms were hand-traced and the selected parameters shown in Figure 2 were measured by single operator. To check for intra-operator reliability, records of 10 cases were selected randomly after one week and landmark identification, tracing and measurements were repeated by the same operator. Intra-operator reliability coefficient was calculated and was found to be high (0.98-1).

2.1. Statistical analysis

The data was statistically analysed using Statistical Package for Social Sciences (SPSS ver 23, IBM Corporation, USA) for Microsoft Windows. Paired parametric data (pre-functional v/s post-functional) was tested using paired t-test.

Table 1: Sample characteristics*

Parameters	**(n = 12)**
Age (Years)	14.25 ± 0.75
Gender	
Male	6 (50.0%)
Female	6 (50.0%)
CVMI Stage	4.50 ± 0.52

* CVMI is Cervical Vertebral Maturation Index

3. Results

Changes achieved in skeletal parameters are depicted in Figure 3 and Table 2. Skeletal parameters such as SNB, Wits, maxillo-mandibular differential, estimated length of mandible (EL-mand), Articulare angle, Gonial angle, Björk's sum, basal plane angle, Sn-GoGn, lower anterior facial height (LAFH), Na-perp-Pog differed significantly at T1 (p value<0.05). Skeletal parameters SNA, Na-perp-PtA, UAFH-LAFH ratio, Y-axis, Saddle angle, Jaraback's ratio, estimated length of maxilla (EL-max) did not differ significantly at T1 (p value>0.05).

Statistically significant changes at T1 were observed for dental parameters U1-NA (angular and linear), L1 to NB (angular and linear), U1-SN angle, IMPA, Inter-incisal angle, L1 to A-Pog, U1 to A-Pog (p value <0.05). U1 to A-vert did not show a statistically significant change at T1. Dentoalveolar changes are shown in Figure 4 and Table 2.

Soft tissue parameters, facial convexity and nasolabial angle revealed statistically significant results at T1 (p value<0.05), while UL to E-line and LL to E-line changes were not found to be significant (p value>0.05) as shown in Figure 5 and Table 2. For airway parameters statistical

Table 2: Changes observed in cephalometric parameters with AdvanSync 2 appliance therapy *

Parameters	PretreatmentT0 (Mean + SD)	Post FunctionalT1 (Mean + SD)	Difference (T1-T0)	% Change	p-value
1. **Skeletal Parameters**	81.58 ± 2.07	81.58 ± 2.07	0.00 ± 0.43	0.00 ± 0.52	1.000
Na					
SNB	75.58 ± 1.98	78.21 ± 2.33	2.62 ± 0.98	3.47 ± 1.30	<0.001
ANB	5.75 ± 1.29	3.71 ± 1.96	-2.04 ± 1.68	-36.20 ± 33.21	0.018
Wits	3.17 ± 1.71	0.92 ± 1.08	-2.25 ± 1.03	-Inf ± 0	0.002
Maxillomandibular Differential	18.92 ± 5.82	22.08 ± 6.10	2.65 ± 1.59	18.62 ± 12.03	<0.001
Estimated length maxilla	74.75 ± 4.67	75.17 ± 4.47	-0.88 ± 1.35	0.60 ± 2.03	0.312
Estimated length mandible	95.42 ± 7.44	98.92 ± 7.42	3.50 ± 1.09	3.69 ± 1.17	<0.001
Jaraback's Ratio	67.86 ± 4.49	68.90 ± 4.91	1.05 ± 2.02	1.55 ± 2.95	0.100
Saddle Angle	125.62 ± 5.15	125.58 ± 5.11	-0.04 ± 0.69	-0.03 ± 0.56	0.838
Articulare Angle	138.92 ± 7.72	140.00 ± 7.50	1.08 ± 0.79	0.79 ± 0.59	<0.001
Gonial Angle	124.00 ± 8.60	125.75 ± 9.16	1.75 ± 0.97	1.39 ± 0.73	<0.001
Bjork's Sum of Angles	388.71 ± 5.24	391.50 ± 5.58	2.79 ± 1.50	0.72 ± 0.38	<0.001
Basal Plane Angle (BP Angle)	21.25 ± 4.35	23.50 ± 4.42	2.25 ± 1.14	10.96 ± 5.84	<0.001
Lower Anterior Facial Height (LAFH)	51.62 ± 5.24	54.25 ± 5.46	2.62 ± 1.15	5.10 ± 2.19	<0.001
Sn Go Gn	28.25 ± 4.45	29.83 ± 4.61	1.58 ± 0.79	5.68 ± 2.91	<0.001
Y Axis	63.58 ± 1.98	63.75 ± 1.76	0.17 ± 0.39	0.27 ± 0.64	0.166
UAFH:LAFH	1.03 ± 0.08	1.07 ± 0.13	0.04 ± 0.10	3.48 ± 9.55	0.082
N Perp- Pt A	-2.00 ± 3.77	-2.00 ± 3.64	0.00 ± 0.43	-6.25 ± 15.54	1.000
N Perp- Pog	-8.17 ± 2.08	-6.92 ± 2.11	-1.25 ± 0.45	-16.01 ± 6.16	0.001
2. **Dental Parameters**					
UI to NA (Angle)	35.58 ± 5.38	31.33 ± 5.25	-4.25 ± 2.77	-11.75 ± 7.59	<0.001
UI to NA (mm)	7.28 ± 2.60	5.64 ± 2.15	1.63 ± 1.21	-18.70 ± 20.97	0.005
LI to NB (Angle)	27.00 ± 6.22	30.25 ± 6.80	3.25 ± 1.36	12.30 ± 4.88	<0.001
LI to NB (mm)	4.67 ± 1.86	5.82 ± 2.00	1.16 ± 0.44	29.03 ± 17.12	<0.001
UI-SN	115.25 ± 7.16	111.67 ± 6.95	-3.58 ± 2.23	-3.09 ± 1.90	<0.001
IMPA	99.42 ± 7.34	102.50 ± 7.04	3.08 ± 1.44	3.14 ± 1.52	<0.001
UI- APog	9.21 ± 2.04	7.33 ± 1.50	-1.88 ± 1.57	-19.15 ± 13.37	0.002
Interincisal Angle	111.17 ± 11.38	114.42 ± 10.94	3.25 ± 1.06	2.99 ± 1.17	<0.001
L1-Apog	2.08 ± 1.38	3.71 ± 1.68	1.62 ± 0.77	Inf ± 0	0.002
UI to A Vert	4.67 ± 1.23	4.17 ± 1.03	-0.50 ± 0.52	-9.58 ± 10.25	0.020
3. **Soft Tissue Parameters**					
Upper lip to E line	1.33 ± 2.10	0.83 ± 2.25	-0.50 ± 1.57	-Inf ± 0	0.286
Lower lip to E line	1.00 ± 3.20	0.83 ± 2.33	0.17 ± 1.66	-52.92 ± 51.86	0.734
Nasolabial Angle	101.29 ± 7.15	108.08 ± 6.37	6.79 ± 3.04	6.82 ± 3.17	0.002
Soft Tissue Convexity	90.25 ± 1.91	92.50 ± 2.35	2.25 ± 1.06	2.49 ± 1.16	<0.001
4. **Airway Parameters**					
Superior Airway	15.92 ± 2.27	16.67 ± 2.74	0.75 ± 0.75	4.44 ± 4.49	0.018
Posterior Pharyngeal Airway	9.33 ± 1.78	10.75 ± 2.14	1.42 ± 0.67	15.14 ± 5.86	<0.001
Hyoid Distance	11.92 ± 4.89	11.25 ± 4.11	-0.67 ± 2.42	-4.35 ± 19.73	0.403
Hyoid Angle	17.67 ± 4.25	17.42 ± 4.44	-0.25 ± 2.18	-1.08 ± 12.89	0.721

*T0 indicates pretreatment; T1, post functional; P, results of paired t-test

Figure 1: (a) : Pre-treatment records of a 12 Y/o male patient with a chief complaint of forwardly placed upper front teeth (b) : AdvanSync TM 2 Fixed functional Appliance in-situ (c) : Post-functional records

Figure 2: Cephalometric Landmarks used in the study: Nasion (N), Soft tissue Nasion (N'), Orbitale (Or), Sella (Se), Porion (Po), Condylion (Co), Articulare (Ar), Gonion (Go), Menton (Me), Gnathion (Gn), Pogonion (Po), Soft Tissue Pogonion (Pog'), Lower lip (Li), Upper Lip (Ls), Subnasale (Sn'), Hyoidale (H)

significance was obtained in the changes obtained in posterior pharyngeal airway space (p value <0.05), while superior airway space, hyoid distance and hyoid angle changes were not statistically significant (p value >0.05). Airway changes are shown in Figure 6 and in Table 2.

4. Discussion

The corrective effect of fixed functional appliances is cumulative of dental and skeletal changes which result in an improvement in the overall esthetics and function.[13] Cacciatore et al in a systematic review reported a 1-degree decrease in ANB, and -3.5mm to 2mm improvement in the Wits and maxillomandibular differentials with the use of functional appliances.[14]

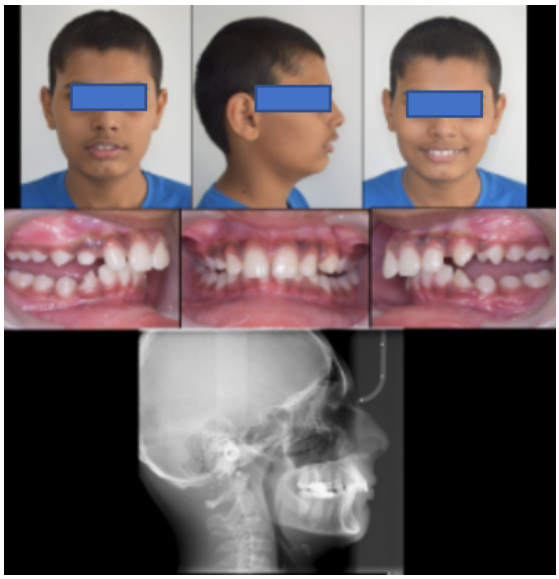

Figure 3: Mean changes in skeletal cephalometric parameters with AdvanSyncTM 2

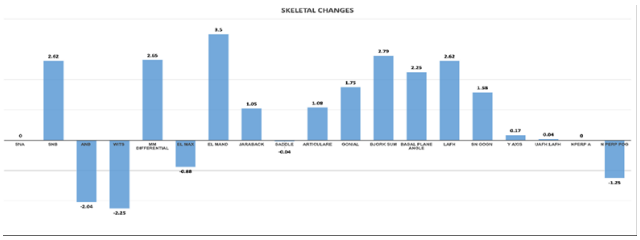

Figure 4: Distribution of mean dental cephalometric changes achieved with AdvanSync TM 2

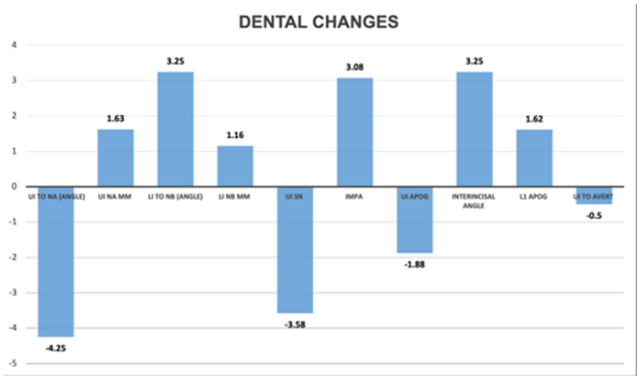

Figure 5: Distribution of mean soft-tissue changes achieved with AdvanSyncTM 2

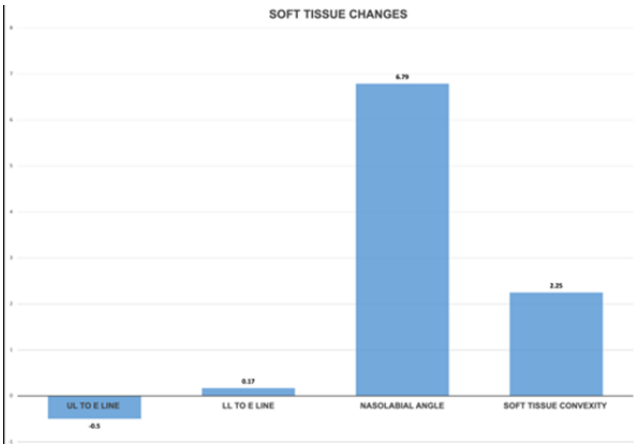

Figure 6: Mean airway cephalometric changes achieved with AdvanSyncTM 2

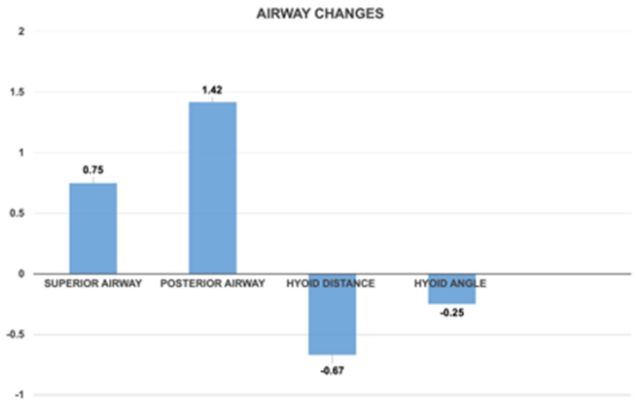

Figure 7:

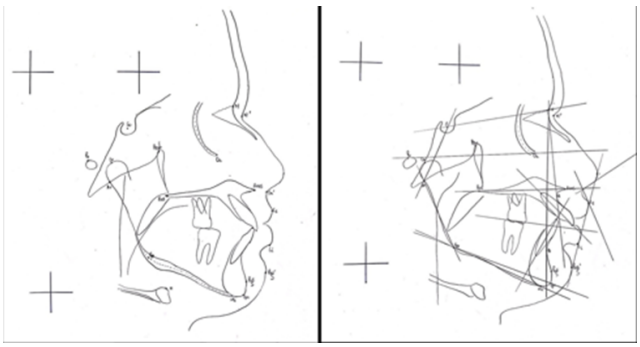

Figure 8:

4.1. Skeletal changes

In the present study, AdvanSync TM 2 produced a statistically significant decrease in the ANB (mean change of 2.04 degrees) by producing a significant increase in the SNB (2.62 degrees). The sagittal correction of the mandible was observed as an improvement in the Wits appraisal (-2.25) and maxillomandibular differential (3.50mm mean increase). Similar results have been reported by Ghaffar et al. Bhonsale et al and Kaushik et al. [11,15,16]

The results of the current study differed from those reported by Mofty et al and Al-Jewair et al who reported on the 'headgear effect' of the appliance. [17,18] In the present study, the sagittal correction in ANB had been significantly contributed to by an increase in the SNB (mean 2.62-degree increase). Mandibular growth was evident by the significant changes in the maxilla-mandibular differentials in the current study. The increase in length of the mandible (Co-Gn) (mean 3.50mm) was found to be statistically significant. Jayachandran et al also reported a mean increase of 7.53 mm of Co-Gn and 5.58mm in Mx-Md differential. [6]

Statistically significant improvement in the facial height with a mean increase of 2.62 mm in the lower anterior facial height (ANS-Me) were also found in the present study being supported by similar reports by Jayachandran et al, Pyarilal et al and Kaushik et al. [6,16,19] Improvement in the lower anterior facial height was supported by an equivalent increase in the gonial angle, basal plane angle, SN-GoGn angle and Y-axis, all denoting the downward rotation of the mandible in addition to its sagittal advancement by the functional appliance.

No statistically significant change in the maxillary growth (EL-max -0.88mm) was observed in the present study. Literature on the maxillary restrictive effect of the appliance is varied with some studies reporting significant skeletal growth restriction while others support no restrictive effect of functional appliances. [13] The dichotomy in maxillary skeletal growth restriction by the appliance can be explained by the method of usage of the appliance between the current study and previous reports. The current methodology is similar to a study by Ghaffar et al, which cites similar non-significant effects on maxillary skeletal. [11]

4.2. Dental changes

In the present study, angular and linear measurements of U1 to NA (Steiner Analysis) were observed to decrease by 4.25 degree and 1.63 mm respectively, while U1 to SN decreased by 3.58 degrees. Though the upper incisors showed statistically significant correction in inclination, the lower incisors proclined significantly with AdvanSync TM 2. IMPA increased by a mean of 3.08 degrees, L1 to NA (angular) increased by 3.25 degrees, L1 to NA (linear) increased by 1.16mm, and L1 to Pt A-Pog by 1.62mm.

Al-Jewair et al reported similar changes in L1 to Pt A-Pog of 0.9mm and IMPA increase of 3.8 degree in the AdvanSync ™ group.[5] Ghaffar et al reported similar results of a 2.13-degree increase in IMPA.[11] These results suggest AdvanSync ™ 2 to produce limited flaring of incisors when used independent of a fixed orthodontic edgewise appliance therapy.

4.3. Soft tissues

AdvanSync ™ 2 produced a retraction of the upper lip relative to Rickett's E-line by 0.50mm. This could be explained by the maxillary restraining effect of the appliance. The lower lip to E-line increased by 0.17mm in Group 2 and can be due to the increase in the mandibular projection due to sagittal advancement and the dentoalveolar effects of the appliance on the lower incisors. Nasolabial angle showed a significant increase of 6.79 degrees, similar to the report by Bhonsale et al.[15] Contrary to the current study, Jayachandran et al reported larger changes in upper lip retraction of 2.54mm while lower lip projection increased by 1mm.[6] Their findings can be attributed to the higher dentoalveolar effects in both maxillary and mandibular parameters, as seen in the AdvanSync ™ sample.

4.4. Airway changes

Treatment with AdvanSync ™ 2 produced statistically significant improvement in upper airway dimensions by 0.75mm and lower airway dimensional changes of 1.42mm, secondary to its effect on mandibular growth and rotation.

Airway changes secondary to functional appliances therapy are attributable to both sagittal advancement of the mandible and its rotation. These therapeutic skeletal effects of functional jaw orthopaedics could aid in increasing the linear dimension of the airway, especially in cases of severe mandibular retrusion. Notwithstanding this, functional appliances are not the primary therapeutic approach in patients of airway and breathing disorders.

5. Limitations of the study

Statistically significant results were obtained for the objectives in the study, though, the following limitations were noted:

1. (a) Study sample size was small and limited to a single centre for the present study. Future prospective and randomized controlled trials in a multi-centric study design are recommended.
   (b) The timeframe of the present study was short, and the long-term stability of the changes could not be ascertained. Studies with long-term follow-up of changes after fixed functional appliance therapy are indicated.

6. Conclusion

Based on the results of the present study, it can be concluded that:

1. (a) The null hypothesis was rejected due to changes observed in skeletal, dental, soft tissue and airway parameters following treatment with AdvanSync ™ 2 FFA.
   (b) AdvanSync ™ 2 proved to be effective in the correction of Skeletal Class II malocclusion in growing patients.
   (c) Skeletal Class II correction with AdvanSync™ 2 was primarily by dentoalveolar changes and limited skeletal changes.
   (d) AdvanSync ™ 2 produced improvement in facial esthetics as examined by the soft-tissue changes.
   (e) Improvements in linear airway cephalometric parameters were noted post-AdvanSync ™ 2 therapy.

7. Source of Funding

None.

8. Conflict of Interest

None.

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