Original Article

Assessment of Changes in Dentoskeletal Parameters Among Class-II Subjects Following Treatment with the Herbst Appliance: A Longitudinal Study

Khurram Shahzad,[1] Omair Anjum,[2] Muhammad Farhan Khan,[3] Khurram Nadeem,[4] Asad Mahmood,[5] Junaid Israr Ahmed Khan[6]

Abstract

Objective: The purpose of this longitudinal study was to investigate dentoskeletal parameter changes in Class II patients after treatment with the Herbst appliance, therefore offering insights into treatment efficacy and results

Material and Methods: A prospective observational design was employed at the Orthodontic Department of Children's Hospital and Institute of Child Health & Avicenna dental College, Lahore in Lahore, Fifty patients who met the inclusion criteria completed pre-treatment assessments, Herbst appliance therapy, and post-treatment evaluations. The data collection includes demographic information, baseline dentoskeletal parameters, and post-treatment measures.

Results: The study included 50 cases, with 34% (n=17) aged 11-12 years and 66% (n=33) aged 13-14 years. Pre-treatment values for SNA were 82.08±0.97, SNB was 75.12±1.32, and IMPA was 95.82±2.32. Post-treatment, SNA decreased to 80.8±1.16, SNB increased to 76.34±1.44, and IMPA rose to 100.62±2.83. Mean differences post-treatment were -1.28±0.61 for SNA, 1.22±0.55 for SNB, and 4.8±1.31 for IMPA, with p-values of 0.07, 0.01, and 0.01 respectively, indicating significant mandibular advancement and lower incisor inclination.

Conclusion: Herbst appliance therapy significantly improved dentoskeletal parameters in skeletal Class II patients, particularly enhancing mandibular position and dental aesthetics. These findings underscore the importance of tailored treatment strategies for optimal orthodontic outcomes.

Keywords: class II malocclusion, dentoskeletal parameters, functional appliance, herbst appliance

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Introduction

Functional appliances are considered to be a very efficient orthodontic therapy, especially for skeletal Class II malocclusions with mandibular retrognathism.[1] Because of their skeletal structure, these malocclusions present difficulties, sometimes demanding orthognathic surgery after the completion of growth, to correct substantial skeletal deformities.[2] Functional appliances like the Herbst appliance offer potential opportunities for dentoskeletal improvements without surgical intervention.[3] Recent research has focused on experiments conducted on mandibular protrusion in developing animals, yielding insights into condylar growth stimulation and glenoid fossa remodeling.[4] The Herbst appliance, known for its effectiveness in Class II malocclusion treatment, has attracted attention for its ability to cause dentoskeletal changes in young adults. Fixed

1. *Department of Orthodontics, Avicenna Dental Hospital, Lahore*
2. *Department of Science of Dental Materials, Lahore Medical & Dental College, Lahore*
3. *Department of Prosthodontics, Baqai Dental College, Baqai Medical University, Karachi*
4. *Department of Oral Medicine, Lahore Medical & Dental College, Lahore*
5. *Department of Oral Biology, Lahore Medical & Dental College, Lahore*
6. *Department of Orthodontics, Lahore Medical & Dental College, Lahore*

Correspondence:
Dr. Khurram Shahzad, *BDS, FCPS Orthodontics, Orthodontics, Senior Registrar Orthodontics, Avicenna Dental College, Lahore.*
Email: drkhurramshahzad01@gmail.com

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functional appliances [FFA], such as the Herbst, require less active patient engagement than removable functional appliances, which rely largely on patient compliance.[5] Furthermore, Class II division 1 malocclusion, the most common sub-classification of malocclusion,[6] has been addressed using a variety of therapeutic approaches. Extraction of the upper first permanent molars has been proposed as a possible therapeutic option, especially in situations of extensive molar damage or previous extractions. Studies have found considerable improvements in the PAR index using this treatment plan, demonstrating its usefulness in obtaining ideal dental results.[7] The Herbst appliance is extensively used in orthodontics for Class II correction, providing benefits like relatively shorter treatment periods and a lower reliance on patient compliance.[5] Its effects include both skeletal and dental changes dental, such as anterior protrusion of the lower dental arch and distalization of the upper arch.[8] However, a variety of skeletal changes are observed among people, which are influenced by characteristics such as gender and treatment duration. One prominent disadvantage of the Herbst therapy is the proclination of the lower incisors, which is caused by the stresses imposed by the appliance.[9] Despite this, the Herbst appliance has therapeutic advantages over other functional appliances, such as continuous 24-hour therapy and no interference with speech.[10] In current dentofacial orthopedics, Herbst appliance therapy followed by a conventional fixed appliance treatment phase, has proven to be an effective strategy for treating severe Class II malocclusions.[11] The first phase, the Herbst appliance phase accomplishes Class II correction, while the second phase of fixed appliance concentrates on ultimate tooth alignment, yielding total treatment results.[12] The current study assesses the dentoskeletal effects of Herbst appliance therapy in skeletal Class II, Class II division 1, mandibular retrognathic individuals. This study aims to provide clinicians with additional data for future differential treatment planning by combining insights from previous research and clinical observations, thereby contributing to the refinement of orthodontic strategies for Class II malocclusions and potentially reducing reliance on surgical interventions.

Material and Methods

This prospective observational study, carried out at the Orthodontic Department of Children's Hospital and Institute of Child Health & Avicenna dental College, Lahore in Lahore, Pakistan from October 2016 till March 2017. IRB No was CPSP/REU/DSG-2014-075-1438 dated 11-06-2016. The sample size was 50 patients, which were carefully calculated to assure statistical significance. This calculation was based on a 95% confidence level and 80% power of test, with an expected mean change in SNA (sagittal relationship of the maxilla to the cranial base) in the study participants of -1.35±1.113. The sample selection procedure was carefully planned to ensure the study's reliability. Non-probability sequential sampling was used, which ensured a methodical app-roach to participant inclusion. Inclusion criteria were carefully defined to capture a specific subset of patients: those with a Skeletal Class II relationship with an ANB angle greater than 4° and an SNB angle less than 78°, aged 11 to 14 years, presenting with an overjet of at least 5 mm, and possessing a specific SN-MP angle range of 32°± 4°. Additionally, bilateral Class II molar and canine relations were required for inclusion. In contrast, patients who had previously received orthodontic treatment were excluded, as well as were those born with missing or removed permanent teeth, with the exception of third molars. Patients with syndromes or skeletal abnormalities were also excluded to ensure that the research cohort was homogenous and devoid of confounding characteristics that may bias the results. The data collection began with the identification of 50 suitable children from the orthodontic clinic at The Children's Hospital in Lahore. The informed consent process was carried out, ensuring that participants were fully informed about their participation in the study and the processes involved. The Institutional Review Board provided ethical approval to ensure that the research was conducted in accordance with the highest ethical standards. Each participant's basic demographic information, such as name, age, residence, and contact information, was thoroughly documented to guarantee proper data recording. Baseline values for dentoskeletal parameters were rigorously gathered to lay the groundwork for pre-treatment evaluation. The Herbst appliance, especially Banded Design, was used during the active therapy period. A wax construction bite was recorded with the jaw in a forward posture, resulting in edge-to-edge incisors. When a normal or corrected overjet was achieved, indicating the finish of active therapy, post-treatment data were methodically gathered.

Results

This study included a total of 50 cases/patients that satisfied strict inclusion/exclusion criteria in order to reveal the Dentoskeletal parameter changes in skeletal Class II patients treated with the Herbst appliance, offering critical insights into orthodontic care techniques. The age distribution study indicated a large proportion of patients aged 11-12 years (34%, n=17), emphasizing the need of early intervention in treating Class II malocclusions during the growth phase **(Table-1).** The remaining 66% (n=33) in the 13-14 age group highlight the possible diversity in treatment results dependent on developmental stage. The gender distribution revealed a greater number of female participants (62%, n=31) than males (38%, n=19), indicating possible gender-related variations in orthodontic treatment responses, which have been seen in earlier study but require more exploration.

Table 1: *Age and Gender distribution (n=50)*

Variable	Categories	N (%)
Age	11-12	17 (34%)
	13-14	33 (66%)
	Mean Age (S.D)	12.54 (1.41)
Gender	Male	19 (38%)
	Female	31 (62%)

The mean changes in Dentoskeletal parameters pre- and post-treatment with the Herbst appliance indicated interesting results. Pre-treatment values for SNA (82.08 ± 0.97) and SNB (75.12±1.32) were within predicted ranges for Class II malocclusions, suggesting a baseline presentation in our study population. The pre-Treatment IMPA score (95.82±2.32), indicates incisor inclination, a key indicator in evaluating treatment success for mandibular advancement**(Table-2).**

Table 2: *Comparison of mean change in dentoskeletal parameters in class II patients treated by twin block (n=50)*

	Para-meters	Pre-Treatment		Post Treatment		Difference		P value
		Mean	SD	Mean	SD	Mean	SD	
Pre-treatment	SNA	82.08	0.97	80.8	1.16	-1.28	0.61	0.07
	SNB	75.12	1.32	76.34	1.44	1.22	0.55	0.01
	IMPA	95.82	2.32	100.62	2.83	4.8	1.31	0.01

Post-treatment evaluations revealed considerable changes. The decrease in SNA (80.8±1.16) post-treatment indicates a positive shift in maxillary position, which aligns with treatment aims to rectify Class II connections. Increased SNB (76.34±1.44) leads to better mandibular placement and facial harmony. The significant rise in IMPA post-treatment (100.62±2.83) suggests an increase in lower incisor inclination.

The mean difference analysis after treatment revealed complex findings. The SNA mean difference (-1.28 ± 0.61) was not statistically significant (p-value: 0.07), indicating minimal changes in maxillary position. However, the SNB mean difference (1.22±0.55) was highly significant (p-value: 0.01), indicating significant mandibular advancement, improving dental and facial aesthetics — an important outcome in Class II correction. The Herbst device increases lower incisor inclination, as evidenced by a substantial IMPA mean difference (4.8±1.31, p-value = 0.01).

Stratification by age and gender allowed for a more thorough study, finding possible moderators impacting treatment results. The observed mean differences highlight the multidimensional nature of Class II correction, underlining the importance of individualized treatment approaches based on patient characteristics and developmental phases. These findings have practical relevance, helping orthodontists optimize treatment options for Class II malocclusions, particularly in young patients receiving Herbst appliance therapy **(Table-3).**

Table 3: *Stratification for data regarding mean difference after treatment with regards to age (n=100)*

	Para-meters	Age: 11-12 years		P value	Age: 13-14 years		P value
		Mean	SD		Mean	SD	
Mean difference	SNA	-1.30	0.64	0.23	-1.24	0.56	0.10
	SNB	1.18	0.53	0.001	1.29	0.59	0.001
	IMPA	4.79	1.11	0.001	4.82	1.67	0.001

Discussion

Our study explores into the intricacies of dentoskeletal alterations caused by the Herbst appliance in Class II malocclusions, providing insight into its therapeutic effectiveness and implications for orthodontic treatment. One important issue investigated is the best time to begin functional appliance therapy. McNamara et al. (2020) highlight the need of timely therapy with the pubertal growth spurt to optimize therapeutic effects.[13] The gender and age-related distributions in our study were carefully adjusted to ensure a strong comparison between pre-treatment and post treatment measurements. According to Carneiro Chagas Tanus (2022), patients with smaller and retrusive mandibles react better to functional appliance therapy, which is an important component in our treatment outcome study.[14] The methodology provides a targeted evaluation of the Herbst appliance's influence on dentoskeletal parameters, yielding useful insights into its therapeutic value for Class II malocclusion. Analysis of sagittal skeletal changes reveals intriguing findings on maxillary and mandibular changes caused by the Herbst device. While no substantial influence on maxillary development was observed, the appliance revealed considerable improvements in mandibular positioning, which were consistent with treatment goals for Class II correction. These findings are consistent with previous research demonstrating the Herbst appliance's usefulness in encouraging mandibular growth and repositioning, particularly in cases with mandibular retrusion.[15,16] The Herbst appliance's substantial improvements in mandibular dimensions contribute greatly to occlusal relationship and facial esthetics, strengthening its function as an effective treatment option for Class II malocclusions.[17] Moving on to dental changes caused by the Herbst device, this appliance focuses on occlusal relationships, molar position and incisor protrusion.[18] These alterations, while important for occlusal correction, also affect vertical dimensions and anterior-posterior tooth placements. Dental alterations, particularly in overjet and molar correction percentages, demonstrated a balanced role for skeletal and dental components in treatment results.[19] Herbst therapy resulted in significant distalization of upper molars and lower incisor protrusion, consistent with existing data on Herbst-induced dental changes.[20] The study's findings support previous literature on the Herbst appliance's influence on dental parameters and emphasize the importance of rigorous and careful monitoring of dental changes during therapy. Vertical skeletal changes, such as increased lower face heights and ramus elongation, demonstrate the Herbst appliance's overall impact on facial morphology and mandibular development.[21] These adjustments not only enhance aesthetics, but also help to stabilize occlusal relation and long-term treatment outcomes.

The study's strengths include its prospective observational design, which allows for long-term data collection and assessment of treatment results in a real-world clinical context. The addition of a well-defined sample size derived using statistical power and confidence levels improves the study's robustness. Furthermore, using consistent data collecting techniques and verified measuring tools improves the reliability and validity of the results. Furthermore, the stratification of data by age and gender aids in the management of potential confounding variables, adding to the study's scientific strength. However, there are certain Limitations to consider. The study's six-month length may not capture long-term therapy effects, particularly skeletal alterations that may continue to evolve after this time period. The use of non-probability sequential sampling may add selection bias, reducing the generalizability of the results to a larger sample. Furthermore, the study's emphasis on dentoskeletal characteristics may ignore other essential considerations, such as patient-reported results or potential therapeutic side effects. Future study might address these limitations by including longer follow-up periods, using randomization to select samples, and conducting a more detailed assessment of treatment results.

Conclusion

The study's findings provide important insights into the Herbst appliance's multifarious impact on dentoskeletal parameters in Class II malocclusions. This study makes a substantial contribution to our understanding of functional appliance treatments and their personalized applications in orthodontic practice by matching treatment scheduling with growth spurt stages and using a thorough approach.

Conflict of interest *None*

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References

1. Ckauhan AK, Alam F, Verma S, Shafaq S. Fixed functional appliances for correction of Class II malocclusion: A review. International Journal of Orthodontic Rehabilitation. 2021 Jan 1;12(1):26.
2. Bergamaschi IP, Cavalcante RC, Fanderuff M, Gerber JT, Petinati MF, Sebastiani AM, da Costa DJ, Scariot R. Orthognathic surgery in class II patients: a longitudinal study on quality of life, TMD, and psychological aspects. Clinical Oral Investigations. 2021 Jun;25:3801-8.
3. Yezdani AA, Sreenivasan P, Padmavati R, Kumar SK, Padmavathy K. Class II Skeletal Jaw Discrepancy Correction with Herbst Appliance. Indian Journal of Public Health Research & Development. 2019 Dec 1; 10(12).
4. Agrawal, K. and Shashikala Kumari, V., 2023. Evaluation of skeletal changes in glenoid fossa, condylar head and articular space following fixed functional appliance therapy using cone beam computed tomography–A clinical prospective study. Journal of Contemporary Orthodontics, 7(2), pp.107-115.

5. Pacha MM, Fleming PS, Johal A. A comparison of the efficacy of fixed versus removable functional appliances in children with Class II malocclusion: a systematic review. European journal of orthodontics. 2016 Dec 1; 38(6):621-30.
6. Stomatologic SI. Worldwide prevalence of malocclusion in the different stages of dentition: A systematic review and meta-analysis. European journal of paediatric dentistry. 2020 Feb;21:115.
7. Booij, J.W., Kuijpers-Jagtman, A.M., Bronkhorst, E.M., Livas, C., Ren, Y., Kuijpers, M.A. and Katsaros, C., 2021. Class II Division 1 malocclusion treatment with extraction of maxillary first molars: Evaluation of treatment and post-treatment changes by the PAR Index. Orthodontics & craniofacial research, 24(1), pp.102-110.
8. Irezli EC, Baysal A. Changes in the craniofacial structures and esthetic perceptions of soft-tissue profile alterations after distalization and Herbst appliance treatment. American Journal of Orthodontics and Dentofacial Orthopedics. 2021 Mar 1;159(3):292-304.
9. Paulo Schwartz J, Boamorte Ravelli T, Barnabé Ravelli D, Ruf S. Effects of Herbst Appliance Treatment on the Mandibular Incisor Segment: a Three-Dimensionally Analysis. Journal of Health Sciences (2447-8938). 2021 Oct 1;23(4).
10. Verma N, Garg A, Sahu S, Choudhary AS, Baghel S. Fixed functional appliance-A Bird's Eyeview. Iosr-Jdms [Internet]. 2019;18(3):67-83.
11. Marchi PG, Muñoz JF, de Arruda Aidar LA, Marchi LC, Dominguez GC, Raveli DB. Dental changes induced by a modified Herbst appliance followed by fixed appliances: A digital dental model analysis. Journal of the World Federation of Orthodontists. 2023 Jun 1;12(3): 131-7.
12. Wei RY, Atresh A, Ruellas A, Cevidanes LH, Nguyen T, Larson BE, Mangum JE, Manton DJ, Schneider PM. Three-dimensional condylar changes from Herbst appliance and multibracket treatment: A comparison with matched Class II elastics. American Journal of Orthodontics and Dentofacial Orthopedics. 2020 Oct 1;158(4):505-17.
13. McNamara Jr JA, McClatchey LM, Graber LW. Part B: Treatment Timing And Mixed Dentition Therapy. Orthodontics-E-Book: Orthodontics-E-Book. 2022 Aug 26:361.
14. Carneiro Chagas Tanus RD, Santiago Júnior O. Behavior of the mandibular length in class II non-growing patients treated with jaw functional orthopedics. Jaw Functional Orthopedics and Craniofacial Growth. 2022 Dec 31; 2(3):151-7.
15. Hosseini HR, Ngan P, Tai SK, Andrews II LJ, Xiang J. A comparison of skeletal and dental changes in patients with a Class II relationship treated with clear aligner mandibular advancement and Herbst appliance followed by comprehensive orthodontic treatment. American Journal of Orthodontics and Dentofacial Orthopedics. 2024 Feb 1;165(2):205-19.
16. Pangrazio MN, Pangrazio-Kulbersh V, Berger JL, Bayirli B, Movahhedian A. Treatment effects of the mandibular anterior repositioning appliance in patients with Class II skeletal malocclusions. The Angle Orthodontist. 2012 Nov 1;82(6):971-7.
17. Fan Y, Schneider P, Matthews H, Roberts WE, Xu T, Wei R, Claes P, Clement J, Kilpatrick N, Penington A. 3D assessment of mandibular skeletal effects produced by the Herbst appliance. BMC Oral Health. 2020 Dec; 20:1-9.
18. Amuk NG, Baysal A, Coskun R, Kurt G. Effectiveness of incremental vs maximum bite advancement during Herbst appliance therapy in late adolescent and young adult patients. American Journal of Orthodontics and Dentofacial Orthopedics. 2019 Jan 1;155(1):48-56.
19. Matthaios S, Tsolakis AI, Haidich AB, Galanis I, Tsolakis IA. Dental and Skeletal Effects of Herbst Appliance, Forsus Fatigue Resistance Device, and Class II Elastics —A Systematic Review and Meta-Analysis. Journal of Clinical Medicine. 2022 Nov 26;11(23):6995.
20. Sangalli KL, Dutra-Horstmann KL, Correr GM, Topolski F, Flores-Mir C, Lagravère MO, Moro A. Three-dimensional skeletal and dentoalveolar sagittal and vertical changes associated with cantilever Herbst appliance in prepubertal patients with Class II malocclusion. American Journal of Orthodontics and Dentofacial Orthopedics. 2022 May 1;161(5):638-51.
21. Giuca MR, Pasini M, Drago S, Del Corso L, Vanni A, Carli E, Manni A. Influence of vertical facial growth pattern on herbst appliance effects in prepubertal patients: a retrospective controlled study. International Journal of Dentistry. 2020 Jan 11;2020.

Authors Contribution

KS: Conceptualization of Project
KS, JIAK: Data Collection
OA: Literature Search
MFK: Statistical Analysis
KN: Drafting, Revision
AM: Writing of Manuscript