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Original article

An innovative esthethic functional appliance for craniofacial growth modulation with 3D analysis of TMJ.

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Abstract

Introduction*: Class II malocclusion, characterized by mandibular skeletal retrusion, often requires functional therapy like "Airway Friendly Orthodontics." Twin Block appliances, designed by William J. Clark, are popular for promoting mandibular growth and improving facial profile but can cause discomfort, impacting compliance. The growing need for aesthetically pleasing solutions led to the creation of the transparent mandibular advancement device. Clear Twin Block improves comfort and aesthetics, enhancing treatment effectiveness.*

Methods*: We used a lottery conduct to randomly assign the 60 patients in this RCT, 30 in each therapy group. Each patient's twin block appliance, or CFJC, was made in accordance with the protocol. Using CBCT and a questionnaire to gauge the patient's opinion of the appliance, pre- and post-treatment records were gathered over a twelve-month period at intervals of 0 months, 6 months, and 12 months.*

Results*: The malocclusion of both groups significantly improved. There were notable differences in the groups' CBCT parameters, particularly in anterior joint space, condylar height, and condylar position. There have also been notable improvements in patient comfort and appliance perception, indicating improved CFJC appliance compliance.*

Conclusion*: The results highlight the CFJC appliance's higher efficacy in producing considerable condylar remodeling, making it the recommended option for treating Class II malocclusion. Additionally, when compared to more conventional choices, patients demonstrated greater compliance with the CFJC appliance. These results corroborate the CFJC appliance's clinical advantage in orthodontic practice by indicating that it not only improves treatment outcomes but also increases patient acceptability and adherence.*

Key Words- *Clear Functional Jaw Corrector, Twin block appliance, Class II malocclusion, Cone Beam Computed Tomography.*

INTRODUCTION:

In order to obtain the ideal occlusion—which balances function, stability, and aesthetics—malocclusion, or a departure from normal tooth alignment, frequently calls for orthodontic treatment. About one-third of people have class II malocclusion, which is typified by mandibular skeletal retrusion and can disrupt sleep and breathing. Functional therapy is used in "Airway Friendly Orthodontics" to promote mandibular growth.[1] One Class II disharmony is corrected using a variety of detachable functional appliances, including the Activator, Bionator, Frankel, and Twin Block. William J. Clark's Twin Block is especially well-liked because to its efficient, speech-friendly design.

The Twin Block appliance mainly causes sagittal alterations, which lengthens the mandible and improves the convex to straight facial profile. It promotes backward disk movement, repositions the condyle forward, and increases the anteroposterior diameter and condyle height. Significant bone development occurs within six months as a result of changes in the glenoid fossa brought on by tissue strain and changed synovium flow. Nevertheless, pain from functional appliances, such as mucosal pressure, soft tissue tension, and trouble speaking, might affect patient compliance.[2] Orthodontists must select suitable appliances and manage discomfort effectively.

Patient compliance significantly influences the success of removable orthodontic appliances.[3] Kevin O'Brien et al. (2003) noted that non-compliance often hampers early Twin Block treatment.[4] Traditional appliance size as well as visible wires are factors in non-compliance. We need wireless appliances that are lighter, more comfortable, and more modern.[5] The fixed Twin Block, though effective, and has better compliance, can cause gingival inflammation, food lodgment, bad odour and discomfort.[6] Clear aligners reduce gag reflexes, improve comfort and appearance, and increase patient satisfaction. By eliminating wire components, the "clear Twin Block" enhances comfort and appearance while preserving the classic benefits of Twin Blocks. This change improves therapy effectiveness and patient compliance.[7] In recent years, transparent teeth positioners, also referred to as aligners, have taken the role of conventional braces for the treatment of mild to severe crowding and extraction conditions. The growing need for aesthetically pleasing solutions led to the creation of the transparent mandibular advancement device. By combining the features of a functional appliance with an aligner, this gadget provides an alternative treatment method.

Many studies have evaluated the skeletal outcome of Twin-block treatment, with mixed findings. Some report showed significant mandibular growth[8], while others note primarily dentoalveolar changes.[9] Twin-block appliances successfully decreased pediatric OSA symptoms, according to Duan J et al. (2022).[10] Temporomandibular joint (TMJ) responses are associated with mandibular growth, and CBCT investigations have demonstrated forward condylar placement and remodeling.[11] Condylar displacement, glenoid fossa modifications, and condylar modifications are all necessary for effective TMJ adjustments. Studies with bigger sample numbers and thorough analyses of TMJ alterations are few.[12-17] Therefore, we conducted this study to obtain more conclusive results.

MATERIALS AND METHODS:

Fabrication of prototype:

Prototypes of the transparent Functional Jaw Corrector (CFJC) were made using thermoformed vacuum transparent "copyplast" material in different thicknesses. These prototypes included acrylic blocks with different mechanical adhesive systems. Following testing of several thicknesses, the transparent thermoformed sheets' 1 mm thickness was selected due to its resilience to mechanical stresses. The acrylic blocks were successfully held firmly inside the CFJC appliance by the addition of tiny grooves along their sides. It is appropriate for clinical application because of its design, which guaranteed both usefulness and endurance.

Outpatients from the department were selected based on eligibility criteria. The total sample included 60 subjects determined using Dr. A P Kulkarni sir software of comprising of both the sexes randomly divided into the two groups by lottery method:

- T: Test group using Clear functional jaw corrector
- C: control group using Twin block

CBCT was taken of the right TMJ region to minimize radiation exposure and standardize the method. The CBCT was taken with a limited field of view.

CBCT imaging protocol:

Figure 1 depicts the cbct images and variables to be studied

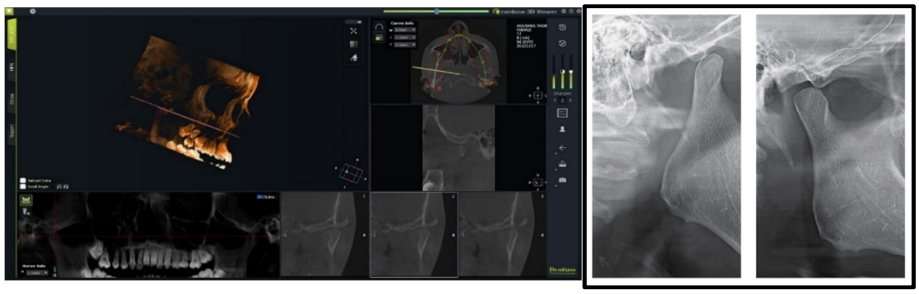

FIGURE 1- CONE BEAM COMPUTED TOMOGRAPHY (CBCT)

The CBCT machine (3D Rainbow) was used to take pictures at 120 kV, 15 mA, and 10 seconds of exposure time. Patients were instructed to keep their teeth in maximal intercuspation and to avoid eating or making any other motions during the scanning time while standing and without an interocclusal separator. The exposure

was set to 110 Kv, 4 mA, and the scanning period was 18 * 16 seconds. The information was in DICOM format. The rainbow™ CT program, which was financed and sold by Dentium in South Korea, was used to upload these data sets for TMJ measurements and anatomic landmark localization. In order to mimic the conventional process used in lateral cephalograms, all of the landmarks were situated on the sagittal view of the midline plane. Every orthogonal plane was used to confirm their placements. Temporomandibular joint and surrounding space examination was done using Rainbow software.

CBCT of right condyle was taken at the start of treatment and at the end of treatment.

Methodology in test group (CFJC):

Fabrication:

The construction bite was installed on models that were put on an articulator. The upper bite block was placed flat over the remaining posterior teeth at an angle to the upper second premolar's mesial surface. The lower block extended mesially to cover the lower first premolar and, if required, merged into the lower incisal capping region. It was inclined from the mesial surface of the premolar. In order to provide more horizontal force components and encourage horizontal mandibular development, the inclined plane was oriented at a 70-degree inclination. Each block's excess thickness (0.5 mm) was cut to make room for the copyplast sheet. After each block was secured to its corresponding cast, the appliance was fabricated using a vacuum-formed process. Figure 2 depicts the CFJC appliance.

Appliance delivery:

FIGURE 2- CLEAR FUNCTIONAL JAW CORRECTOR APPLIANCE

Figure 3 depicts the pre-treatment extraoral and introral photographs of CFJC appliance (test group)

FIGURE 3- PATIENTS PRETREATMENT INTRAORAL AND EXTRAORAL PHOTOGRAPHS OF CFJC APPLIANCE (EXPERIMENTAL GROUP)

The appliance was finished and trimmed for smooth surfaces after fabrication. During formation, intraoral fitting was guaranteed. The patient received care and wear instructions, and a follow-up was conducted two weeks later to assess pterygoid response. Any appliance repairs were covered by follow-up recalls at six weeks. Patients were advised to wear the appliance continuously and follow the instructions as depicted in Figure 4.

FIGURE 4- PATIENTS INTRAORAL PHOTOGRAPHS WITH CFJC APPLIANCE (EXPERIMENTAL GROUP)

The posttreatment extraoral and intraoral photographs of the patients depicted in figure 5.

FIGURE 5- PATIENTS POSTTREATMENT INTRAORAL AND EXTRAORAL PHOTOGRAPHS WITH CFJC APPLIANCE (EXPERIMENTAL GROUP

Methodology in control group (Twin block appliance): Traditional twin block fabrication technique was followed as depicted in figure no. 6 which shows patients pretreatment intraoral and extraoral photographs with twin block appliance (control group).

FIGURE 6- PATIENTS PRETREATMENT INTRAORAL AND EXTRAORAL PHOTOGRAPHS WITH TWIN BLOCK APPLIANCE (CONTROL GROUP)

Figure 7 shows patients intraoral photographs with twin block appliance (control group).

FIGURE 7- PATIENTS INTRAORAL PHOTOGRAPHS WITH TWIN BLOCK APPLIANCE (CONTROL GROUP)

Figure 8 shows patients posttreatment intraoral and extraoral photographs with twin block appliance (control group).

STATISTICAL ANALYSIS:

Analysis was conducted using SPSS version 20 (IBM SPSS Statistics Inc. Chicago, Illinois, USA). The unpaired t test (for intergroup comparison) was used for quantitative data comparison of all variables included in the study.

Results:

Comparing the two groups' CBCT data revealed statistically significant variations in the mean values for anterior joint space, condylar position, and condylar height (Table 1).

Table 1: Intergroup comparison of CBCT parameters between twin block and CFJC group.

Parameter	Groups	Mean	Std. Deviation	t value	p value
Condylar position	Twin Block	.3623	1.03777	-2.731	.008
	CFJC	.9850	.69498		
Condylar height	Twin Block	-.7900	.67696	-11.656	.000
	CFJC	1.2003	.64535		
Condylar width	Twin Block	1.1237	1.32515	-1.496	.140
	CFJC	1.5317	.68949		
Posterior Joint Space	Twin Block	3.6287	25.20830	.489	.627
	CFJC	1.3760	.84388		
Anterior Joint Space	Twin Block	-.3633	.70156	2.554	.013
	CFJC	-1.0320	1.25084		
Superior condylar space	Twin Block	-1.1190	.61598	1.366	.177
	CFJC	1.4317	Find and put		

Table 2 shows that statistically significant differences were found in the intergroup comparison of parameters assessing patient comfort and perception of the appliance, indicating better compliance with the CFJC Appliance ($p < 0.05$).

Table 2: Intergroup comparison of patient comfort and perception between twin block and CFJC group.

Parameter	Groups	Mean	Std. Deviation	t value	p value
Pain perception	Twin Block	6.3167	.82507	11.250	.000
	CFJC Appliance	4.0833	.70812		
Patient Comfort	Twin Block	6.5167	.51668	-2.614	.011
	CFJC Appliance	6.9500	.74683		
Appliance appeal/ appearance	Twin Block	5.3667	.65566	-11.843	.000
	CFJC Appliance	7.3900	.66765		
Complexity of regimen	Twin Block	5.4333	.69149	-5.705	.000
	CFJC Appliance	6.4333	.66609		
Cost	Twin Block	5.5167	.59427	-6.517	.000
	CFJC Appliance	6.5167	.59427		
Maintenance of oral hygiene and appliance	Twin Block	5.4167	.64438	-6.010	.000
	CFJC Appliance	6.4167	.64438		
Visibility of appliance in mouth	Twin Block	5.5500	.53094	13.604	.000
	CFJC Appliance	3.6000	.57834		
Confidence	Twin Block	5.4667	.58624	-6.606	.000
	CFJC Appliance	6.4667	.58624		
Patient perceived	Twin Block	5.5700	.52729	-14.690	.000

values for appliance	CFJC Appliance	7.5700	.52729		
Speech related problems	Twin Block	6.3367	.72420	10.696	.000
	CFJC Appliance	4.3367	.72420		

Discussion:

Class II malocclusion is prevalent among Indian populations, with rates ranging from 10% to 25%.[18] These rates are influenced by a variety of factors, including genetics, cultural traditions, and environment, as well as differences in diagnostic standards and research techniques. It has been shown that boys are more likely than girls to exhibit Class II malocclusion, indicating a gender preference.[19] In order to manage this serious tooth problem in India, early identification and the right orthodontic treatments are essential. Although there is disagreement on the best time to begin myofunctional treatment, research indicates that it works best between phases three and four of cervical vertebral development, which occurs around or immediately after puberty.[20,21] This study includes ages 10-15 years for both genders, aligning with Tanner et al.'s findings of peak height velocity at approximately 12 years in girls and 14 years in boys.[22]

The study evaluated condylar position changes post-treatment with Twin Block and CFJC appliances. CFJC group showed more significant shifts, consistent with prior research by ShanthiniPriya et al.[23] Condylar movements included anterior shifts, akin to findings with Herbst appliances[24], Twin Block[25-27], and other functional appliances.[28] Condylar height increased notably in both groups, contrasting with decreased heights in untreated controls.[29] Condylar width increased, more so in CFJC, aligning with findings by Parvathy et al.[30] Condyle growth in functional therapy enhances mandibular length and volume[31] promoting sagittal and vertical condylar dimensions. TMJ changes noted anterior and posterior joint space adjustments post-treatment, similar to findings by Yildirim et al.[32] and Bayram et al.[33] Functional appliances influence articular fossa growth, aiding mandibular repositioning.[34] Despite challenges in assessing fossa remodeling, TMJ space alterations indicate treatment efficacy. The study's comprehensive analysis supports CFJC's superiority in achieving favorable skeletal, dental, and soft tissue outcomes in Class II malocclusion over Twin Block within a 12-month treatment period.

Patient compliance and satisfaction were assessed for Twin Block and CFJC appliances based on pain perception, comfort, appearance, regimen complexity, cost, hygiene, visibility, confidence, and speech issues. Both groups showed significant differences: Twin Block had higher pain perception, visibility, and speech-related problems, while CFJC was favored in comfort, appearance, regimen simplicity, cost-effectiveness, patient confidence, and perceived appliance value. Similar findings in patient satisfaction were reported by Farzaneh Golfeshan et al. in 2018[35], highlighting reduced speech issues with clear aligners. R G Oliver's study[36] and Thirumurthi AS et al.'s[37] psychological assessments also emphasizes patient satisfaction and challenges associated with orthodontic treatment, aligning with our study's outcomes.

Conclusion:

This prospective clinical study aimed to evaluate condylar position changes using cone beam computed tomography in treating Class II malocclusion with the Twin Block and Clear Functional Jaw Corrector (CFJC) appliances. Key findings include:

1. TMJ changes were observed in both groups, with the CFJC group exhibiting more pronounced changes than the Twin Block group.
2. CFJC showed enhanced efficacy due to more significant condylar remodeling as compared to the Twin Block appliance.
3. Patient compliance was higher in the CFJC group, possibly due to reduced treatment duration compared to traditional Twin Block therapy.

These results highlight that CFJC appliance emerges as a preferred treatment for Class II malocclusion, demonstrating superior efficacy in enhancing skeletal, dental, and soft tissue changes, along with promoting condylar remodeling coupled with improved patient compliance. Therefore, the CFJC appliance not only improves treatment results but also enhances patient acceptance and adherence, highlighting its significant clinical benefits in orthodontic practice. The appliance's ability to achieve superior treatment outcomes and

foster better patient compliance underscores its potential as an effective solution for managing Class II malocclusion. This supports its role as a preferred choice among orthodontic treatments, emphasizing its capacity to deliver favorable therapeutic results while ensuring patients maintain consistent engagement with their treatment plan throughout the treatment process.

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