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Removable Functional Orthodontic Apparatus and Mandibular Condyle

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Abstract

This study aims to compare the impact of functional dynamic orthodontic appliances on mandibular condyle bone density in patients with Class I and Class II malocclusion during their growth and development phases. 12 patients among the ones who met the inclusion criteria were divided into 2 groups. The groups were determined as Maxillary expansion appliance group (Group A), Twinblock-Monoblock group (Group B), In the Maxillary expansion device group (Group A) and Twinblock-Monoblock (Group B) group, the value of mandibular condyle bone density decreased at the end of treatment compared to pre-treatment ($p<0.05$). In different malocclusion groups, some functional dynamic orthodontic appliances (maxillary expansion device and Twinblock-Monoblock) experienced an increase in bone density in the mandibular condyle, It is important to conduct orthodontic treatment by analyzing the results obtained with the use of these appliances.

Keywords: Fractal analysis; Orthodontic treatment; Orthodontic malocclusion; Removable functional appliances.

1. Introduction

Functional appliances are categorized as either removable or fixed, depending on whether they can be inserted and removed by the patient [1,2]. Removable functional appliances are frequently preferred in orthodontic practice due to several advantages: they are easy for patients to use, facilitate oral hygiene, and are relatively low-cost [3,4]. However, these appliances also have drawbacks. They are generally bulky, may interfere with speech and swallowing by restricting tongue space, and cannot be used in conjunction with fixed orthodontic mechanics [4].

Functional jaw orthopedics aims to induce tissue changes necessary for correcting skeletal jaw discrepancies through functional stimulation. These stimuli originate from the orofacial muscles such as the masticatory, mimic, and tongue muscles either from passive tension during rest or from active contraction during function. Functional dynamic appliances are used to deliver these stimuli effectively [5,6].

Several hypotheses have been proposed to explain the mechanisms underlying functional treatment. According to Wolff's Law, changes in bone microstructure, driven by mechanical loading, lead to predictable morphological adaptations. Functional forces generated by muscle tonus at rest and contractions during orofacial activity are transmitted to the jawbones via muscles attached to the skeletal structures or through the periodontal ligaments [7].

This study aims to evaluate the effects of functional dynamic appliances on mandibular condyle bone density in patients with Class I and Class II malocclusion, based on the current technical literature.

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2. Materials and Methods

This retrospective study was conducted by analyzing pre-treatment and post-treatment panoramic radiographs of patients who underwent dynamic orthodontic treatment. A total of 12 patients were included, all of whom had received functional dynamic orthodontic appliances as part of their orthodontic therapy. Patients were grouped based on the type of appliance used.

- Group A: Maxillary expansion appliance (n = 6)
- Group B: Twin-block/Monoblock appliances (n = 6)

Inclusion criteria for the study were as follows:

- Availability of high-quality panoramic radiographs at the start (T0) and end (T1) of treatment
- Absence of any disease or pathology in the mandibular condyle region visible on panoramic imaging
- No congenital or acquired craniofacial anomalies (e.g., cleft palate, trauma)
- No history of prior orthodontic treatment

The primary objective was to assess changes in mandibular condyle bone quality. For this purpose, trabecular bone structure was evaluated using fractal analysis. This method calculates a fractal dimension**,** which quantifies the complexity of repeating trabecular patterns within the bone. Panoramic radiographs were converted into TIFF format for digital processing. Only radiographs with appropriate image quality (i.e., no magnification errors, contrast issues, or blurring) and taken in or near natural head position were selected for analysis.

Malocclusion classes were defined based on clinical and cephalometric criteria:

- Class I malocclusion: ANB angle between 0° and 4°
- Class II malocclusion: Class II molar-canine relationship, convex profile, ANB > 4°, and a neurodivergent growth pattern

Descriptive statistics were expressed as mean (X) ± standard deviation (SD). Differences in mandibular condyle bone quality between groups were assessed using one-way ANOVA. Statistical analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA).

This study was approved by the Human Ethics Research Committee of Izmir Kâtip Çelebi University.

3. Results

When patients were evaluated by appliance groups, the trabecular structure of the mandibular condyle bone showed statistically significant differences before and after treatment in all groups ($p < 0.05$).

- In the Maxillary Expansion group (Group A), the mean fractal dimension was 1.3162 ± 0.0657 before treatment and 1.2252 ± 0.0446 after treatment.
- In the Twin-block/Monoblock group (Group B), it was 1.3654 ± 0.1238 before treatment and 1.2094 ± 0.1852 after treatment.

These findings indicate that each appliance type induced measurable changes in the trabecular pattern of the mandibular condyle.

4. Discussion

This study examined the changes in mandibular condyle bone quality following treatment with different functional dynamic orthodontic appliances in patients with various types of malocclusion. Notably, the Maxillary Expansion and Twin-block/Monoblock groups exhibited a decrease in trabecular bone density after treatment.

Functional dynamic appliances are widely preferred due to their low cost, ease of use, and clinical effectiveness [5,8]. In treating Class II malocclusions, which are not purely sagittal or vertical discrepancies but often involve transverse deficiencies, functional appliances play a critical role. McNamara and Brudon [9] emphasized the importance of

maxillary width in mandibular positioning, noting that transverse constriction can displace the mandible posteriorly [10]. Volk et al. [11] found that although maxillary expansion improved Class II relationships in some patients, the improvement was not solely attributed to functional mandibular advancement.

Among these appliances, Twin-block systems offer significant clinical advantages over monoblock appliances, particularly due to their two-piece design, which allows simultaneous maxillary expansion and mandibular advancement [12,13]. Studies have shown that functional appliances promote downward and backward rotation of the mandible, increase lower facial height, and limit maxillary forward growth [14–17]. Specifically, Twin-block and Monoblock appliances have been reported to decrease the SNA angle by restricting sagittal maxillary development [18,19].

While many studies support posterior mandibular rotation and changes in mandibular plane angle with functional appliances [15,18], some researchers have found no significant alteration [20,21]. Furthermore, mechanical stress resulting from orthodontic forces has been suggested to contribute to condylar remodeling or resorption [22,23], which may explain the observed variations in trabecular structure in this study.

5. Conclusion

This study demonstrated that the fractal dimension of the mandibular condyle an indicator of trabecular bone complexity decreased following treatment with Maxillary Expansion and Twin-block/Monoblock appliances. These findings suggest that different functional dynamic orthodontic appliances exert distinct mechanical influences on the mandibular condyle.

Further clinical and longitudinal studies are necessary to confirm these findings and elucidate the underlying biological mechanisms responsible for these changes.

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