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# Effects of removable functional orthodontic apparatus on mandibular condyle bone quality

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## Abstract

**Aim:** This study aims to compare the impact of dynamic functional orthodontic appliances on mandibular condyle bone density in patients with Class I, Class II, and Class III malocclusion during their growth and development phases.
**Methodology:** The histories of patients with three separate malocclusions who received dynamic functional orthodontic appliance treatment were analyzed in this retrospective study. Twenty-eight patients met the inclusion criteria and were divided into four groups: maxillary expansion devices (Group A), twinblock/monoblock devices (Group B), face masks (Group C), and chincups (Group D). The fractal analysis approach was used to determine the mandibular condyle bone density by analyzing panoramic films taken from the patients at the beginning (T0) and end (T1) of treatment.
**Results:** In Groups A and B, the results of the mandibular condyle bone fractal analysis decreased at the end of treatment compared with the pre-treatment results ($p < 0.05$). In Groups C and D, the post-treatment results were better than the pre-treatment ones ($p < 0.05$).
**Conclusion:** Among the different malocclusion groups, some dynamic functional orthodontic appliances (maxillary expansion and twinblock/monoblock devices) enabled an increase in bone density in the mandibular condyle, while some (face masks and chincups) decreased the density. 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

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## Introduction

Orthodontic malocclusions can be treated using several appliances and procedures, depending on the severity of the incompatibility between the current jaws, morphological changes in the skeletal and dental structures, patient's age, growth and development periods, patient's cooperation, and treatment expectations (1). Functional appliances are classified as removable or fixed on the basis of their ability to be installed and removed by the patient (2). Due to the advantages of removable functional appliances, such as ease of wearing and removal by the patient, ease of oral hygiene, and low cost, these appliances are frequently preferred in orthodontic clinics (3, 4). However, dynamic functional appliances cannot be used with fixed mechanics and are voluminous; the patient experiences difficulties in speaking and swallowing because the tongue area is restricted (4).

Functional jaw orthopedics aims to apply the tissue changes needed for the treatment of skeletal abnormalities of the jaw with functional stimuli of the organ. Functional stimuli in the face, masticatory, mimic, and tongue muscles are caused by the tension that occurs during the resting state or the contractions that occur during the masticatory function. These functional stimuli are supplied using dynamic functional appliances (5, 6). Some hypotheses have been proposed by researchers to better explain the mechanism of functional treatment. According to Wolff theory, changes in the microstructure of the bone cause morphological changes in mathematical order. Functional forces formed by stimuli resulting from the tonuses in the resting state and contractions of the orofacial muscles during function are transmitted to the bones through muscles adhering to the jawbones or periodontal ligaments (7).

This study aims to establish the impact of dynamic functional appliances on mandibular condyle bone density in patients with Class I, Class II, and Class III malocclusion within the framework of the technical literature.

## Materials and Methods

This study was conducted by retroactively examining the pre- and post-treatment radiological films of patients who were admitted for orthodontic treatment and received dynamic orthodontic treatment. The inclusion criteria for the individuals in our study were the availability of a panoramic film at the beginning of treatment, absence of any disease in the area investigated with the panoramic film, absence of congenital and/or acquired defects (such as cleft palate and trauma), and absence of previous orthodontic treatment. Twenty-eight patients who received dynamic orthodontic treatment met these criteria and were examined. The groups were categorized based on the dynamic functional orthodontic appliances that were used.

Group A: Maxillary expansion appliance (seven patients)

Group B: Twinblock/monoblock devices (seven patients)

Group C: Face masks (seven patients)

Group D: Chincups (seven patients)

Mandibular condyle data were compared in all groups between the panoramic films obtained before orthodontic treatment (T0) and the panoramic films taken after orthodontic treatment was completed (T1).

**Table 1.** Mandibular condyle bone formation changes according to removable functional orthodontic apparatus groups

| | Mandibular condyle bone fractal dimension before orthodontic treatment (T0) | Mandibular condyle bone fractal dimension after orthodontic treatment (T1) | p |
|---|---|---|---|
| Maxillary Expansion Appliance | 1,3564±0,0767 | 1,3352±0,0556 | $p < 0.05$ |
| Twinblock-Monoblock | 1,3354±0,1368 | 1,1294±0,1652 | $p < 0.05$ |
| Face mask | 1,2616±0,0949 | 1,3211±0,0558 | $p < 0.05$ |
| Chincup | 1,3345±0,1356 | 1,3443±0,1652 | $p < 0.05$ |

This analysis was performed with the approval of the human ethics research committee at İzmir Kâtip Çelebi University (Decision no: IKCU-2021-0270). In the examination of mandibular condyle bone quality, trabecular bone changes were compared using fractal analysis. The fractal analysis process produces a value known as the fractal scale, which expresses the complexity of repeating geometric patterns. The panoramic films of the study patients were converted to TIFF format, and fractal analysis was applied to the images. The panoramic images studied were those that did not have any issues that would have affected the picture quality (such as magnification, poor contrast, and turbidity), as well as those that were taken in positions similar to the natural head position and/or natural head position.

The participants with skeletal Class I malocclusion had ANB values in the range of $0° \leq ANB \leq 4°$. In the Class II malocclusion group, the individuals had Class II molar-canine relationships, convex profiles, ANB angles greater than 4, and a neurodivergent growth model. The patients in the Class III malocclusion group had Class III molar-canine relationships, concave or flat profiles, ANB angles less than 0, and a neurodivergent growth model.

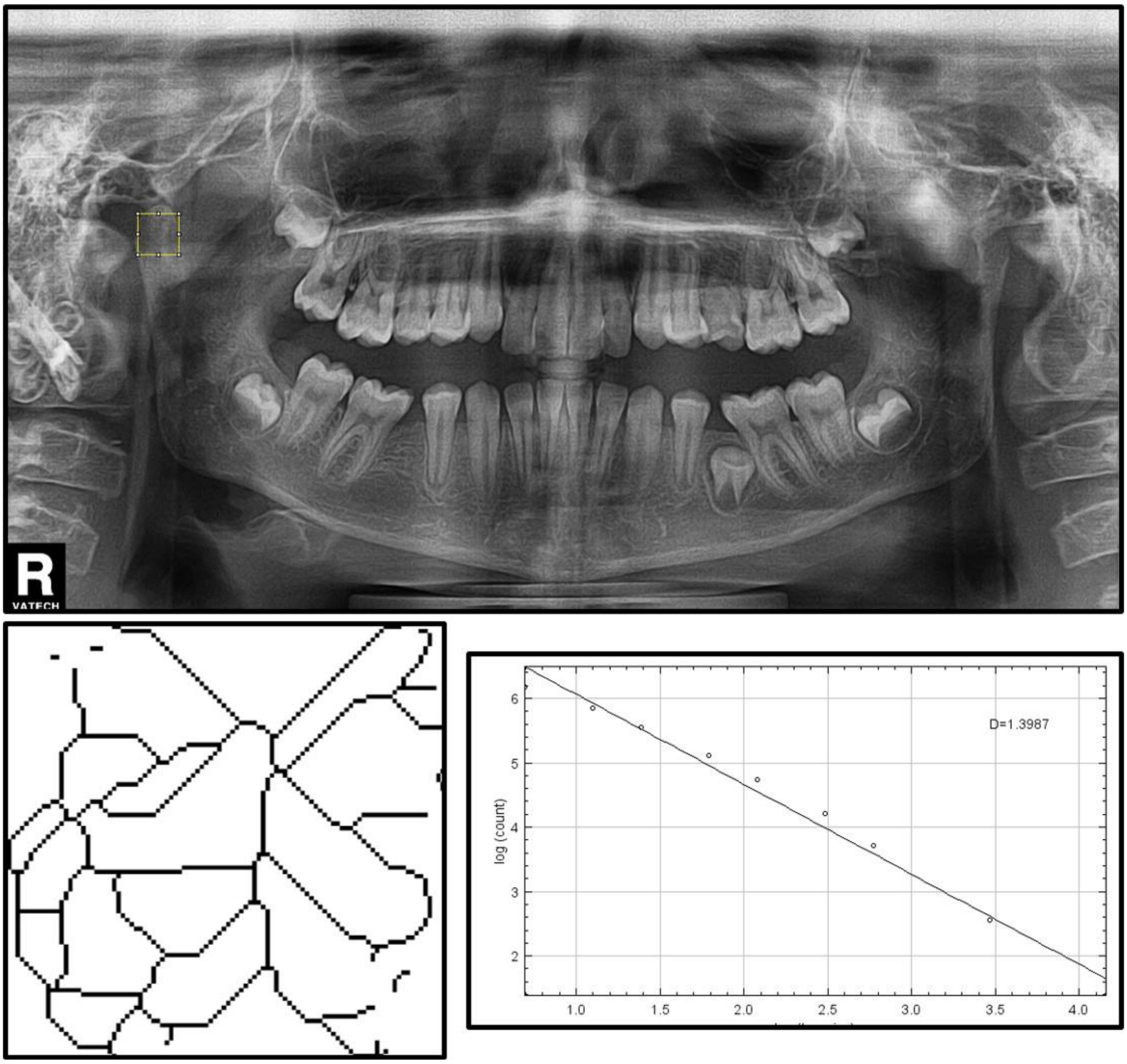


Figure-1: Determination of mandibular condyle bone density by fractal analysis.

## Statistical analysis

Descriptive statistics are shown as X (mean) ± SS (standard deviation). ANOVA was used in the interactions of the mandibular condyle bone quality groups of patients separated by dynamic functional appliances. The statistical package program SPSS software version 20.0 was used in the analysis of the dataset (IBM Corp., Armonk, NY, USA).

## Results

The patients in each appliance group were examined. The trabecular structure of the mandibular condyle bone in the maxillary expansion system group (Group A) was determined as 1.3564 ± 0.0767 before treatment and 1.3352 ± 0.0556 after treatment, and this difference was statistically significant ($p < 0.05$).

The trabecular structure of the mandibular condyle bone was 1.3354 ± 0.1368 before treatment and 1.1294 ± 0.1652 after treatment in the twinblock/monoblock group (Group B), and this difference was statistically significant ($p < 0.05$).

The trabecular structure of the mandibular condyle bone was found to be 1.2616 ± 0.0949 before treatment and 1.3211 ± 0.0558 after treatment in the face mask group (Group C), and this difference was statistically significant ($p < 0.05$).

In the individuals in the chincup group (Group D), the trabecular structure of the mandibular condyle bone 1.3345 ± 0.1356 before treatment and 1.3443 ± 0.1652 after treatment, and this difference was statistically significant ($p < 0.05$). In individuals in the Chincup group (Group D), the trabecular structure of the mandibular condyle bone was determined as 1,3345±0,1356 before treatment and 1,3443±0,1652 after treatment. The difference in mandibular condyle bone trabecular structure between individuals in Group D before and after treatment was found to be statistically different ($p < 0.05$).

## Discussion

In this study, the changes in bone quality in the mandibular condyle region after orthodontic treatment were examined in different patient groups. Among the different malocclusion groups, some dynamic functional orthodontic appliances (maxillary expansion and twinblock/monoblock devices) increased the bone density in the mandibular condyle, while some (face masks and chincups) decreased the density.

Dynamic functional appliances are commonly preferred because of their low cost, ease of attachment and removal by patients, and good results obtained in studies (5, 8). Dynamic functional appliances are used for various malocclusions. Class II malocclusions, according to McNamara and Brandon (9), are not only a sagittal and vertical problem but also a powerful transversal junction. Relative stenosis in the maxilla causes the mandible to become stuck and positioned farther back (10). Volk et al. stated in their study examining changes in the lower jaw after maxillary expansion in Class II patients that the Class II relationship improved in half of the individuals in the study group, but this improvement was not due to mandibular functional shift (11).

A significant advantage of twinblock appliances, which are commonly used in orthodontics, over monoblock appliances is that they consist of two distinct lower and upper bite blocks that are independent of each other, which means that upper jaw enlargement and functional treatment may be done concurrently (12, 13). Technical literature states that the use of functional appliances improves the vertical development of the lower jaw, posterior rotation of the lower jaw, and lower face height (14,15). By moving the mandible forward, functional appliances apply force to the maxilla in opposite directions. As a consequence, maxillary growth in the sagittal direction is minimal (16, 17). Monoblock and twinblock appliances restrict the sagittal development of the upper jaw, and the SNA angle decreases (18, 19). In their study examining monoblock and twinblock appliances, Tümer and Gültan (14) discovered an SNA angle increase of 0.08 mm in the monoblock group and a decrease of 0.23 mm in the twinblock group. In addition to the many studies in the technical literature reporting an improvement in mandibular plane angle and mild posterior rotation in the mandible with the use of dynamic functional appliances (15, 18), some researchers argue that there is no substantial change in the mandibular plane angle with the use of dynamic functional appliances (20, 21). Orthodontic procedures have been reported to cause mechanical stress on the condyle, and this stress may initiate condylar resorption or accelerate established resorption (22, 23).

## Conclusions

The condyle fractal analysis value increased after treatment with maxillary expansion and twinblock/monoblock devices in orthodontic treatment patients, but the value decreased in the face mask and chincup groups. The reason for this increase and decrease is the effect of orthodontic treatment with dynamic functional appliances on the condyle area. However, further clinical studies are required to verify this hypothesis.

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**Ethical Approval:** Ethics committee approval was received for this study from Human Ethics Research Committee at Izmir Katip Çelebi University in accordance the World Medical Association Declaration of Helsinki, with the approval number: IKCU-2021-0270

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