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Research Article

Mandibular Asymmetry Evaluation in Class II Subdivision Patients Treated by Asymmetric Application of the Forsus™ Fatigue Resistant Device (FRD)

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Abstract

Background: The purpose of this evaluation is to determine the condyle and ramus asymmetry of the mandible in class II subdivision patients treated by asymmetric application of the Forsus™ FRD.

Methods: Measurements for evaluating the asymmetry of the mandible were done on the panoramic radiographs of 15 (six male and nine female) patients with class II subdivision treated by the Forsus FRD with asymmetric application (mean age 14.20 ± 1.06 years) from the archive. The study was conducted on pretreatment and posttreatment panoramic radiographs. To assign the differences between the measurements, the Kruskal-Wallis test, ANOVA and the homogeneity of variance of the Welch test were used.

Results: Comparison of condyle, ramus, condyle-plus-ramus height and gonial angle measurements showed no statistically significant differences (p > 0,05). No gender-related differences were found between pretreatment and posttreatment data.

Conclusion: Although condylar height measurements show differences; patients with class II subdivision malocclusion have symmetrical condyle and asymmetric use of Forsus™ is an effective device for correcting class II subdivision malocclusion.

Keywords: *Fixed Functional Appliance; Orthopantomograph; Class II Subdivision; Mandibular Asymmetry*

Introduction

Asymmetry can be both a helper and an adversary of orthodontic treatments. The aim of treatment planning is to determine whether the face, especially the mandible which forms the basis of the profile, is symmetrical both functionally and morphologically when starting to treat a case [1]. A class II subdivision anomaly is an anomaly with a wide variety of etiologic factors showing both class I and class II malocclusion characteristics [2]. Studies on skeletal asymmetry, as well as mandibular asymmetry [3,4], indicate that the glenoid fossa position on the class II side is more lateral and distal [5,6] and the distance between the mental and mandibular foramen is shorter than on the class I side in the mandible [7]. Furthermore, there are studies on dental asymmetry showing that unilateral distal location of the lower first molar (Type 1) [8-12] or mesial location of the upper molars (Type 2) [10,12]. Evaluation of both skeletal and dental factors and determining whether there is a functional shift is also important for the treatment plan [6].

Considering the etiologic factors in class II subdivision anomalies, there are many treatment methods ranging from surgical treatment and orthodontic treatment using many intraoral and extraoral appliances (intermaxillary elastics, fixed functional appliances, extraoral traction, orthodontic distalizer appliances, miniscrews) to asymmetric extraction [13-16]. Especially in class II subdivision patients treated in the postpeak period, a fixed functional appliance may be considered a good option. Forsus™ (3M Unitek, CA, USA), a semirigid appliance which is used for functional orthodontic treatment, can be a beneficial and patient compliance-free option for class II malocclusion treatment [15,17-19]. Studies that have been conducted recently on class II subdivision treatment show that the use of Forsus™ with asymmetric applications can be useful [14,15]. The purpose of using asymmetric Forsus™ in these cases differs in class I and class II sides. On the class II side, the Forsus™ spring applies distal force to the upper molars and mesial force to the lower first premolar, the purpose of using it here is to correct the class II malocclusion. On the class I side, the Forsus™ spring is placed between the canine and first premolar to obtain occlusal balance and the purpose of using it here is to maintain class I relationship [15].

The methods used by Habets., *et al*. [20,21] and Kjellberg., *et al*. [22] are often preferred for measuring asymmetry in the mandible. In particular, the method outlined by Habets., *et al*. is very effective for assessing vertical asymmetry of the mandible and calculating the condyle and ramus heights to compare both sides of the mandible for many anomalies, which include sagittal malocclusions, transversal malocclusions, and different skeletal patterns [3,23-28].

Although cephalometric [29], panoramic [3] and CBCT [30] studies have shown that dental asymmetry is more common than skeletal asymmetry in the class II subdivision anomaly, there are also studies that emphasize skeletal asymmetry by stating that the mandible is shorter on the class II side and that the condyle is asymmetrical due to the location difference of the glenoid fossa and maxilla [3,5]. Although the skeletal effect of the Forsus™ on the maxilla and mandible is controversial, the effects on the maxillary/mandibular anteroposterior relationship and the occlusal and mandibular plane provide class II correction [31].

No published study on this topic was found after searching the literature. Therefore, the goal of this study was to determine the mandibular asymmetry of the condyle and the mandibular asymmetry of the ramus in a class II subdivision patient group treated by asymmetric application of the Forsus™ FRD device.

Materials and Methods

The study protocol was approved by the Ethics Committee of the School of Medicine (20-9/18), Ege University. According to the power analysis with 0.05 level and 80% power, the needed minimum sample size was 15 for the group. Patient's data were selected from the archives. The study was performed on panoramic radiography of 15 (six male and nine female) patients with class II subdivision (pretreatment and posttreatment data) who were treated by the Forsus™ FRD with asymmetric application. A control group could not be formed and because of being an archive study, all the data contained treated patients.

When selecting the study group, it was ensured that the patients have the following features:

1. Class II subdivision malocclusion
2. Moderate crowding
3. Overbite that slightly deviates from the normal value
4. Value of overjet slightly above the normal value
5. Mandibular midline deviation
6. Normal maxillary midline position
7. No functional lateral mandibular shift

8. No orthodontic treatment before
9. No previous facial trauma
10. On the class I side, Forsus springs were incorporated between the canine and the first premolar, and on the class II side between premolars for asymmetric application in the mandible
11. The Forsus™ FRD was used until the molar relationship was corrected and the minimum period of use of the Forsus™ FRD should be six months.

According to their records, all patients were aged between 12 and 16 years (mean age 14.20 ± 1.06 years). The patient group to be examined was selected from the archive by evaluating the intraoral photographs, plaster models, clinical examination notes, lateral cephalometric films, panoramic films, and the patient's anamnesis. Orthopantomograms are radiographs that are routinely used before starting the treatment and after finishing the treatment in clinics. These radiographs were exposed using the same machine (Trophy Radioloqie, Vincennes, France), which had been made standard beforehand. All radiographs were taken by the same attendant. All patients were positioned according to the rest position of the lips and Frankfort horizontal plane was used for the head orientation. All pretreatment OPGs were taken immediately prior to treatment. All the post-treatment OPGs were taken immediately when the brackets were removed. All the films traced and measured and the ImageJ tracing program was used. Anatomical structures such as condyle, ramus, and corpus of mandible were determined on the program. An A-line was drawn between the outermost point of the condyle (X) and of the ramus (Y). A vertical B-line was drawn to the A-line from the highest point of the condyle. The junction point was called the Z point. Condylar height (CH) (the distance between X and Z) and ramus height (the distance between X and Y) were determined. At the middle of the symphysis of the mandible, the O point was constructed. Between the O point and the lower border of the mandible, a C-line was constructed and the gonial angle was measured between the A-line and C-line (Figure 1). The asymmetry of the condyle, ramus, and condyle-plus-ramus were measured following the formula developed by Habets., *et al*. [21]:

Asymmetry index (AI): $I(CH_{right}-CHl_{eft}) / (CH_{right}+CH_{left})I$ x 100.

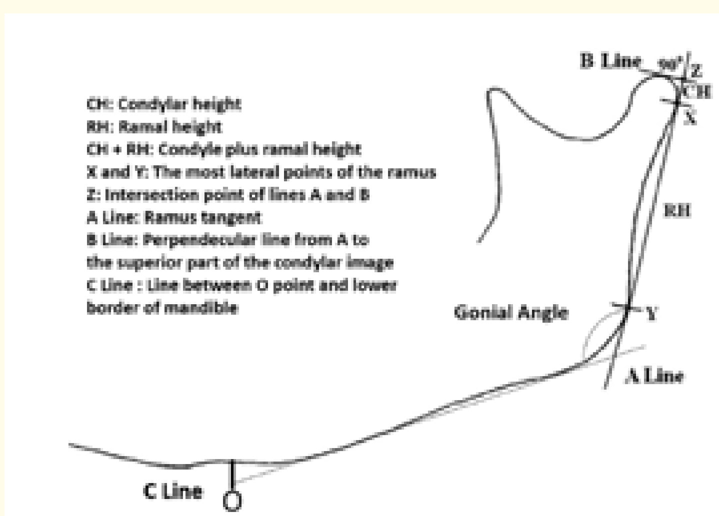

Figure 1: *Measuring method according to Habets., et al.*

Statistical analysis

For determination of interrater reliability, 15 randomly selected OPG were re-evaluated at 2-week intervals. The SPSS software package (IBM SPSS 22, SPSS Inc, Chicago, Ill) was used for all statistical analyses. Descriptive statistics were computed. To evaluate gender-related difference, for the measurements of condyle, ramus and condyle-plus-ramus AI, an independent samples t-test was used. The Kruskal-Wallis test, Anova and the homogeneity of variance of the Welch test were used. To determine the statistical differences between all groups, a Bonferroni test and Tamhane's T2 test were used based on variance homogeneity to further analyze the difference. To determine the mean changes in both sides, paired t-tests were used. To compare mean changes between both sides, a Mann Whitney U test and an independent t-test were performed. Furthermore, $p < 0,05$ was used as the statistical significance level.

Results

27 class II subdivision patients in the archive were treated with asymmetric Forsus™ application. 3 of them were excluded from the study because there were deficiencies in the initial data, 5 of them had deficiencies in the final data, and 4 of them had artefacts that would hinder the examination in their x-rays. 15 patients were evaluated because the power analysis told us that 15 patients were sufficient for analysis. When we evaluated the results, no gender-related difference was found for vertical heights, gonial angle, and asymmetry indices between intragroup comparisons of pretreatment and posttreatment data. Therefore, data for both genders were brought together. Intraclass correlation coefficients ranged from 0.926 to 0.971 for measurements of panoramic analysis. Comparison of condyle, ramus, condyle -plus-ramus measurements and gonial angle for pretreatment and posttreatment class I side and class II side; condyle, ramus, condyle -plus-ramus and gonial angle measurements did not show any statistically significant differences ($p > 0,05$) (Table 1). Descriptive statistics of all asymmetry index data between pretreatment and posttreatment of patients are presented in table 2. Mean changes and comparison between pretreatment - posttreatment data are presented in table 3.

	Pretreatment					**Posttreatment**				
	Class I		**Class II**			**Class I**		**Class II**		
Variable	**Mean**	**SD**	**Mean**	**SD**	**Test**	**Mean**	**SD**	**Mean**	**SD**	**Test**
CH	6.24	.41	6.78	.46	.10	7.22	.582	7.81	.55	.20
RH	60.49	6.92	59.08	6.91	.58	61.58	6.77	62.82	6.38	.60
Ch+RH	66.73	6.99	65.87	7.06	.73	68.80	6.77	70.64	6.47	.45
Gonail angle	126.88	1.51	127.66	1.85	.21	127.78	1.58	126.91	1.80	.16

Table 1: *Compression of pretreatment and posttreatment data of class II subdivision patient.*

**p < 0.05.*

	Pretreatment				**Posttreatment**				
Variable	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Test**
CH Index	4.15	1.46	1.46	6.26	4.01	1.90	1.42	7.19	.79
RH Index	1.18	.46	.46	1.69	1.03	.58	.21	2.17	.44
CH+RH Index	.68	.40	.07	1.25	1.34	.57	.52	2.61	.10

Table 2: *Descriptive statistics of all asymmetry ındex data between pretreatment and posttreatment of class II subdivision patients.*

**p < 0.05.*

	Class I			Class II			
Variable	Mean	SD	Test	Mean	SD	Test	Intergroup P
CH	.97	.35	.000*	1.03	.28	.000*	.000*
RH	1.08	.51	.000*	3.73	.90	.000*	.000*
Ch+RH	2.06	.76	.000*	4.77	1.08	.000*	.000*
Gonail angle	.90	.50	.000*	-.75	.70	.001*	.000*

Table 3: *Mean changes in class II subdivision subjects and comparison between pretreatment - posttreatment.*

**p < 0.05.*

Discussion

OPG is the most frequently used imaging modality during routine patient examination. Its use is preferred in almost every clinic, as it can be easily obtained and can show almost all of the area that is important for dentistry with a single film. Both sides of the mandible can be seen in OPG and it has been used for evaluating right and left height differences and vertical measurements, which are condylar, ramal and total heights [20,21,32]. The presence of both sides of the mandible on the same film make OPG a useful examination tool to evaluate asymmetry. Although the accuracy of the evaluation is questioned, this method was used in many studies [21,22]. Panoramic radiographs, which are noninvasive, cheap, and easy to obtain, can give acceptable results about asymmetry [33]. Many imaging methods are used in asymmetry evaluation; however, all of them have a limitation that makes their use non-routine. CBCT images give exact information about asymmetry but they are expensive and emit more radiation than OPGs [27-30,34,35]. The submental vertex view can cause distortion because of its location far from the mandible. Posteroanterior cephalometric film also has some limitations [36]. Although OPG is not the gold standard, it is the most commonly used method in asymmetry evaluation [33].

For repeatability and reliability of measurements on OPG, the patient's head location is very important. The patient's head should be well centered in the headholder of the machine [20,21]. In our study, OPG films were taken in the same conditions. The films which are not suitable for examination and analysis were not included in the study. Studies investigating gender differences of condylar asymmetries etiology showed no statistically significant differences [32]. In this study, we did not find any significant gender difference in mandibular asymmetry measurements and index evaluations.

Most of the studies in the literature are morphological studies that used different imaging methods to examine the difference between normal occlusion and various malocclusions [3,7,11]. Although there are studies that investigated changes in occlusion before and after treatment mechanics were applied to class II subdivision patients according to the literature [12,13,15] there are no studies that evaluated asymmetry. Consequently, our findings could not be compared.

Both pretreatment and posttreatment condylar height values in the class I side were smaller than in the class II side; however, no statistically significant differences were found (p > 0,05). Pretreatment ramus and condyle-plus-ramus height values were higher in the class I side than the class II side, whereas posttreatment ramus and condyle-plus-ramus height values were higher in the class II side than the class I side. More changes occurred in the class II side than the class I side; however, the differences were not statistically significant (p > 0,05). Pretreatment gonial angle values in the class II side and posttreatment gonial angle values in the class I side were higher; however, no statistically significant differences were found (p > 0,05). Huang., *et al*. showed that the body of mandible height, ramus of mandible height and full mandible height did not show a significant difference between the two sides, although the mandibular condyle head height and mandibular condyle process height in the class I side were bigger than in the class II side [30]. This finding is incompatible with ours.

To evaluate asymmetries in temporomandibular disorders patients and different types of malocclusion, the method used by Habets., *et al*. [20,21] can be used. Habets., *et al*. [20] suggest that because of technical problems that may occur during filming, all values higher than 3% should be taken into account in vertical asymmetry assessment. In this study, in class II subdivision patients, only CH index values were greater in both pretreatment and posttreatment data (4,1553 ± 1,46031%, 4,0113 ± 1,90507%); however, the difference was statistically insignificant. Many research studies in the literature that evaluated the asymmetry of the condyle by using this method found that the all values were higher than 3% [20,21,32]. These values can be caused by the morphological and positional differences between the two sides of the condyle heads. Moreover, this condition may be due to malocclusion; however, it can also be morphological without a pathological condition. Different researchers reported positional and formal differences between the two condyle heads [34]. In the evaluation of asymmetry on OPG, it is found that the measurement of the condylar height is not reliable [33]. Condyle-plus-ramus index values below 3% were found, indicating nonasymmetry; however, the difference was not significant ($p > 0,05$) between pretreatment and posttreatment index values. Many studies argue that there is no problem in the position of the mandible in patients with class II subdivision, whereas in the class II side, molar location is mainly dentoalveolar [10,35]. In the present study, we did not do any dentoalveolar measurements; however, this idea is supported by no vertical asymmetry at vertical posterior heights. Surgical approaches in the correction of skeletal class II subdivision anomalies provide very favorable results, while dentoalveolar approaches should be considered when no skeletal anomalies were found. Treatment of this malocclusion includes asymmetric premolar extraction [36], intermaxillary elastic use [15], headgear applications [13] and functional treatment [15,35]. In this study, mandibular asymmetry evaluation was performed using the records of class II subdivision patients treated by asymmetric application of the Forsus™ FRD. Both the class I side and the class II side show significant differences between pretreatment and posttreatment data (*$p < 0,05$). When we evaluated intergroup differences, the change in the class II side for all measurements showed significant differences ($p < 0,05$). More changes occurred in the class II side than the class I side. The study conducted by Akin., *et al*. showed that treating dental arch asymmetry by asymmetric Forsus application provides good occlusal results and asymmetric application of Forsus is an efficient option for these patients [35-38].

Limitation of the Study

This study has some limitations, for example, the sample size is small and the research was conducted without a control group. Since the study was planned retrospectively, the accuracy of the study depends on the availability and accuracy of orthodontic records. This was the first study on evaluating the asymmetry in class II subdivision patients using asymmetric application of Forsus™ devices. Therefore, comparing the results with those of previous studies is not possible.

Conclusion

In conclusion; the asymmetric use of Forsus™ results in the elimination of dentoalveolar asymmetry in the treatment of patients with class II subdivision by correcting the class II side while balancing the class I side. Although condylar height measurements show differences, these patients have symmetrical condyles and asymmetric use of Forsus™ is efficient for correcting class II subdivision malocclusion. The asymmetric use of Forsus™ does not affect skeletal asymmetry in the treatment of class II subdivision.

Declaration of Conflicting Interests

The author declared that there is no conflicts of interest with research, authorship, publication of this article.

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