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Effects of Early Unilateral Mandibular First Molar Extraction on Condylar and Ramal Asymmetry

Efectos de la Extracción Temprana del Primer Molar Mandibular Unilateral Sobre la Asimetría Condilar y Ramal

Koray Surme[1]; Hayri Akman[1]; Tansu Cimen[2] & Mehmet Akin[3]

SURME, K.; AKMAN, H.; CIMEN, T. & AKIN, M. Effects of early unilateral mandibular first molar extraction on condylar and ramal asymmetry. *Int. J. Morphol., 41(2)*:395-400, 2023.

SUMMARY: Craniofacial symmetry is an important factor in creating a harmonious facial appearance. Genetic and external factors may cause the formation of mandibular asymmetry. The aim of this study was to evaluate vertical mandibular asymmetries in adolescents who had unilateral mandibular first permanent molar (FPM) teeth extracted at an early age. The study group consisted of 60 subjects (30 females, 30 males with a mean age of 16.18±1.04 years) who had their mandibular permanent first molar tooth extracted before the age of 12, and the control group consisted of 60 healthy subjects (30 females, 30 males with a mean age of 16.23±0.92 years). Condylar asymmetry index (CAI), ramal asymmetry index (RAI), and condylar-ramal asymmetry index (CRAI) were calculated using panoramic radiographs of the subjects. Independent samples t-test was used to evaluate the differences between groups. CAI, RAI, and CRAI values were similar between male and female subjects in both control and study groups, and no statistically significant difference was found ($p>0.05$). No statistically significant difference was observed between the group who had their mandibular first permanent molar teeth extracted at an early age and the control group ($p>0.05$). CAI values were relatively higher in both groups, but there was no significant difference between the CAI, RAI, and CRAI values between the groups.

KEY WORDS: Condylar asymmetry; Mandibular asymmetry; Panoramic radiography; Tooth extraction.

INTRODUCTION

Craniofacial symmetry is an essential factor in creating a balanced and harmonious facial appearance. Asymmetries observed in the mandible, which is a part of the stomatognathic system, may cause aesthetic and functional problems (Sezgin *et al*., 2007). An utterly symmetrical face is not possible, and asymmetry is a naturally occurring condition. This asymmetry can range from simple asymmetries that cannot be clinically detected to abnormal asymmetries (Liukkonen *et al*., 2005; Van Elslande *et al*., 2008). Mandibular asymmetry might occur with combinations of genetic and environmental factors. Factors that may cause asymmetry are trauma, infections, developmental anomalies, muscle problems, syndromes, occlusal interferences, temporomandibular joint diseases, and posterior cross-bite (Van Elslande *et al*., 2008; Ferro *et al*., 2011).

The first permanent molar (FPM) teeth play an important role in forming a balanced occlusion, but these teeth are often decayed as they are exposed to the oral environment at an early age (Gill *et al*., 2001). In addition, the prevalence of molar incisor hypomineralization (MIH) affecting FPM teeth was reported to range from 2.5 % to 40.2 % (Cho *et al*., 2008; Soviero *et al*., 2009). Therefore, it is often necessary to extract FPM teeth at an early age (Morita *et al*., 1994). As a result of the early extraction of FPM, there may be problems such as tipping towards the extraction region in adjacent teeth and extrusion of the opposite teeth. Besides, unilateral tooth extraction may change the chewing habits of the patient (Caglaroglu *et al*., 2008). Such problems may cause mandibular asymmetry.

Habets *et al*. (1988) introduced a method of

[1] Department of Pediatric Dentistry, Faculty of Dentistry, Alanya Alaaddin Keykubat University, Antalya, Turkey.
[2] Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Alanya Alaaddin Keykubat University, Antalya, Turkey.
[3] Department of Orthodontics, Faculty of Dentistry, Alanya Alaaddin Keykubat University, Antalya, Turkey.

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comparing the vertical lengths of the left and right condyle and ramus to evaluate the vertical asymmetry of the posterior mandible. This method has been used frequently to evaluate asymmetry in TMD diseases, Class II, Class III malocclusions, patients with cleft lip and palate, and patients with cross-bite (erro *et al*., 2011; Abad-Santamaría *et al*., 2014; Kasimoglu *et al*., 2015).

Although studies investigating the relationship between sagittal and transversal orthodontic anomalies (Ferro *et al*., 2011; Kasimoglu *et al*., 2015; Leonardi *et al*., 2020; Evangelista *et al*., 2022), cleft lip and palate (Abad-Santamaría *et al*., 2014; Prasad *et al*., 2022), temporomandibular joint disorder patients (Sfondrini *et al*., 2021), and mandibular asymmetry have increased in recent years, studies evaluating the effect of tooth extraction on mandibular asymmetry are limited. Halicioglu *et al*. (2013) investigated mandibular asymmetry in patients who had bilateral early FPM tooth extraction, and Thiesen *et al*. (2017) investigated mandibular asymmetry in patients with posterior tooth loss. Therefore, the aim of this study was to evaluate condylar and ramal asymmetry in patients with unilateral mandibular FPM tooth extraction at an early age, using the method of Habets *et al*. (1988).

MATERIAL AND METHOD

Ethical Considerations. The present study was approved by the local ethical committee of our university (approval number: 2020/22-18), and all patients' parents signed an informed consent that accepts the use of patient data for scientific studies.

Data Collection Procedure. The sample consists of a study group of 60 subjects (30 females, 30 males) and a control group of 60 subjects (30 females, 30 males) aged between 14.00 and 17.99 years. Subjects in the control and study group meet the following criteria: Class I canine and molar relationships; except for the third molars, all teeth are present; no major medical history and no history of trauma; no carious lesions, extensive restorations, or periodontal pathology. The tooth extraction group included subjects with unilaterally mandibular FPM tooth extracted before the age of 12. Panoramic radiographs taken from patients who have passed at least 5 years after extraction of the FPM were included in the study. The subjects were randomly selected from the patients who applied for orthodontic treatment. Since panoramic radiographs are a routine diagnostic method used in the Orthodontics Department, patients were not exposed to additional radiation for this study. The age and sex distributions in the groups for all subjects are shown in Table I.

Table I. Comparison of mean ages of control and study groups.

Sex	Control		Study		P value
	N	Mean Age ±	N	Mean Age ±	
Female	30	16.32 ± 0.85	30	16.20 ± 0.62	0.205
Male	30	16.15 ± 0.76	30	16.05 ± 0.90	0.178
Total	60	16.23 ± 0.92	60	16.18 ± 1.04	0.232

Radiographic Evaluation. All radiographs were taken by the same radiology technician, and all the subjects were positioned with their head oriented with the Frankfurt horizontal plane parallel to the horizontal plane. The lips of the subjects were positioned in a resting position, and the midline was adjusted correctly. The radiographs were performed using a Planmeca Promax 2D (Helsinki, Finland) with 68 kV, 5 mA, and 16 s parameters. Evaluation of digital images was done using Planmeca Dimaxis Classic 4.1.4 version software (Planmeca, Helsinki, Finland) software.

All radiographs were traced and measured using the same computer by an experienced oral and maxillofacial radiologist (TC), who was unaware of which radiograph belonged to which group. The method of Habets *et al*. (1988) was used to evaluate mandibular asymmetry. The most lateral point of the condyle is marked as O1, and the most lateral point of the ramus is marked as O2. The line passing through these points is called "A-line". The line perpendicular to the A-line at the top of the condyle is called the "B-line". The intersection point of the two lines is called the Z point. The distance between points Z and O1, the distance between point O1 and point O2, and the distance between point Z and O2 indicate the condylar height (CH), ramal height (RH), and condylar and ramal height (CRH), respectively (Fig. 1). The following formula is used to measure the condylar asymmetry index (CAI), ramal asymmetry index (RAI), and condylar-ramal asymmetry index (CRAI).

$$Asymmetry\ index\ = \frac{right - left}{right + left}\ x\ 100$$

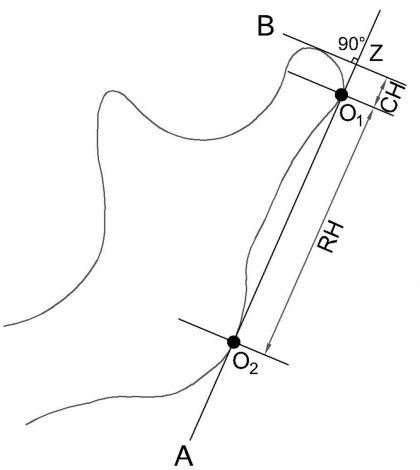

Fig. 1. Measurement method according to Habets *et al*. O1 and O2 indicate the most lateral points of the image; A line was the ramus tangent; and B line was the perpendicular line from A to the superior part of the condylar image. Z indicates the intersection point of lines A and B. CH and RH indicate condylar and ramal height, respectively.

Sample Size Calculation. In this study, sample size calculation was based on Pandis' (Pandis, 2012) formula, a significance level of 0.05 and a power of 80 % to display a difference of 0.70 % (±0.61 %) for the condylar asymmetry between study and control groups. Minimum twenty-five patients were required in each group according to the power analysis.

Statistical Analysis. Descriptive data include age and sex. Shapiro-Wilks' normality test and Levene's variance homogeneity test were applied to analyze the distribution of the data, and it was observed that the data were distributed normally. Therefore, the independent samples t-test, which is one of the parametric tests, was used to compare asymmetric index values between sexes and groups and to compare the age of the groups.

In order to test the reproducibility, 25 randomly selected panoramic radiographs were reevaluated 2 weeks after being evaluated blindly by the same researcher. Dahlberg's formula was used to determine the method's error, and it was observed to be within acceptable limits. Paired samples t-test was applied to test the significance of the difference between the first and second measurements, and no statistically significant difference was found between the measurements ($p>0.05$). IBM SPSS 21.0 software (International Business Machines Corp, New York, USA) was used for data analysis. The significance level was set at $p<0.05$.

RESULTS

The study consisted of 120 subjects, and the mean chronological ages of the study and control groups were 16.18±1.04 and 16.23±0.92, respectively (Table I). There was no statistically significant difference between the control and study groups in terms of mean chronological ages of the subjects ($p>0.05$).

The means, standard deviations (SD), and independent samples t-test results of the CAI, RAI, and CRAI values of the males and females in the control and study groups are shown in Table II. Independent sample's t test results showed that there was no statistically significant difference in CAI, RAI, and CRAI values between male and female subjects in both control and study groups ($p>0.05$). The asymmetry index values of the control and study groups are shown in Table III. CAI values were higher than RAI and CRAI values and were 6.91±4.02 and 7.27±5.16 for the control and study group, respectively. There was no statistically significant difference in CAI, RAI, and CRAI values between the control and study groups ($p>0.05$).

Table II. Comparisons of asymmetric index values between the control and study groups according to sex.

	Female		Male		P value
	Variable	Mean ± SD	Variable	Mean ± SD	
Control	CAI	6.78 ± 4.13	CAI	7.04 ± 3.83	0.304
	RAI	3.12 ± 2.02	RAI	3.37 ± 1.99	0.264
	CRAI	1.98 ± 1.25	CRAI	2.16 ± 1.58	0.198
Study	CAI	7.12 ± 5.03	CAI	7.42 ± 5.47	0.416
	RAI	2.94 ± 2.27	RAI	3.25 ± 2.11	0.208
	CRAI	2.05 ± 1.44	CRAI	2.41 ± 2.13	0.086

Table III. Comparisons of asymmetric index values between the control and study groups.

	N	Control	Study	P value
		Mean ± SD	Mean ± SD	
CAI	60	6.91 ± 4.02	7.27 ± 5.16	0.208
RAI	60	3.25 ± 2.01	3.10 ± 2.18	0.317
CRAI	60	2.07 ± 1.42	2.23 ± 1.77	0.124

DISCUSSION

Facial asymmetries have been evaluated with imaging techniques used in dentistry for a long time. Panoramic radiographs are among the techniques used for this purpose (Van Elslande *et al*., 2008). The mandible can be examined bilaterally with panoramic radiographs. It is also a cost-effective method, and patients are exposed to relatively less radiation dose (Caglaroglu *et al*., 2008; Rodrigues *et al*., 2019). In this study, existing panoramic radiographs were used to evaluate the condylar and ramal asymmetries of children who had their mandibular FPM teeth extracted at an early age, using the method of Habets *et al*. (1988).

Three-dimensional computed tomography imaging is the gold standard, but the patient's relatively high radiation exposure and the high cost of the device limit its use (Kasimoglu *et al*., 2015). Panoramic radiographs are routinely used for dental examination. Previous studies have evaluated the validity of panoramic radiography in measuring the ramus and condyle area (Kjellberg *et al*., 1994; Momjian *et al*., 2011; Lim *et al*., 2018). These studies indicated that machine type and positioning errors were limiting factors, but panoramic radiographs could be used in the measurement of the posterior mandible. It has also been reported that the reproducibility of the panoramic film is acceptable when the patient's head is correctly fixed in the head holder in the imaging device, and the head is centered (Larheim & Svanaes, 1986). In

panoramic radiographs, the magnification factors differ less in the vertical dimension than the horizontal dimension. The magnification is uniform, so it has been reported that this may not significantly affect the measurements (Abad-Santamaría *et al.*, 2014). Therefore, in this study, radiographs were taken with the same device by an experienced radiology technician, and attention was paid to the correct positioning of the patients. Low-quality radiographs were excluded.

It has been reported that unilateral or bilateral cross-bite and cleft lip and palate may cause mandibular asymmetry (Kasimoglu *et al.*, 2015; Veli *et al.*, 2011; Paknahad *et al.*, 2018). There are also studies reporting that Class II and Class III malocclusions can cause mandibular and condylar asymmetry (Sezgin *et al.*, 2007; Al Taki *et al.*, 2015). Therefore, patients with skeletal Class II or III malocclusion, cleft lip and palate, and cross-bites were excluded from this study.

Permanent first molars are among the teeth with the highest incidence of tooth loss. Since these teeth are the first permanent teeth to erupt into the mouth parents may mistake these teeth for primary teeth. It is also reported that the incidence of extraction is higher because these teeth are exposed to environmental factors for a longer time than other permanent teeth, and they are one of the most affected teeth by hypoplasia (Barbato & Peres, 2009). Studies have reported that the prevalence of extraction of first permanent molar teeth is more than 30 % in various countries (Susin *et al.*, 2006: Barbato & Peres, 2009). For permanent first molars with poor prognosis, the ideal chronological age of extraction has been suggested as 8-10.5 years (Eichenberger *et al.*, 2015). If tooth extraction is performed at a later age, space may not be completely closed, and orthodontic problems may occur. After the extraction of the first permanent molars, extrusion in the opposite teeth, tipping in the second permanent molar tooth, and asymmetrical chewing habit may develop (Lin *et al.*, 2007). These may adversely affect the balance of the occlusion.

Habets *et al.* (1988) stated that a change of 1 cm when positioning the patient's head may cause an asymmetry value of 3 %. Therefore, an asymmetry index of more than 3 % should be evaluated as posterior mandibular vertical asymmetry. In this study, the CRAI values were below the 3 % threshold, the RAI values were about 3 %, but the CAI values were significantly higher than these levels in both the control and study groups. Consistent with the findings of this study, Halicioglu *et al.* (2013) and Abad-Santamaría *et al.* (2014) reported the CAI values of patients in the control group as 7.04 and 9.87, respectively.

In the present study, regarding CAI, RAI, and CRAI values, there was no statistically significant difference between the control (6.91±4.02, 3.25±2.01, and 2.07±1.42, respectively) and study (7.27±5.16, 3.10±2.18, and 2.23±1.77, respectively) groups. Caglaroglu *et al.* (2008) evaluated the effect of early tooth extraction on asymmetry using postero-anterior cephalometric radiographs and, in contrast to this study, reported that unilateral first molar extraction during growth and development may cause significant skeletal asymmetry. This difference may be due to the different radiographic methods and landmarks used in the studies. In agreement with this study, Halicioglu *et al.* (2013) reported that bilateral extraction of mandibular first molars did not significantly affect condylar and ramal asymmetry. In this study, similar to other studies, no statistically significant difference was found between sexes in the control and study groups in terms of CAI, RAI, and CRAI values (Kasimoglu *et al.*, 2015; Paknahad *et al.*, 2018).

It has been reported that congenital facial asymmetry occurs in healthy individuals belonging to groups with different genetic origins, but facial asymmetry and mandibular asymmetry are diagnosed using different parameters (Filiptsova *et al.*, 2019). There are limited studies in different races evaluating the effect of tooth extraction on mandibular asymmetry. Thiesen *et al.* (2017) studied on Brazilian population and concluded that there was no association between mandibular asymmetries and missing teeth in the posterior region of the dental arch. Halicioglu *et al.* (2013) studied on Turkish population and concluded that mandibular asymmetry due to early bilateral mandibular first molar extraction does not occur in healthy individuals. Further studies are needed to evaluate the relationship between tooth extraction and mandibular asymmetry among different races.

The limitation of this study was that it was performed on panoramic radiographs, not three-dimensional tomography. Although tomography is the gold standard, it is not used routinely in orthodontic examination because the patient is exposed to more radiation, so panoramic radiography was used in this study. CBCT imaging method was used in some studies evaluating vertical asymmetry in patients with problems such as cleft lip and palate, posterior cross-bite (Veli *et al.*, 2011; Paknahad *et al.*, 2018). In this study, the subjects consisted of healthy individuals who had a molar tooth extracted before. The use of radiological devices with higher radiation doses would not be ethically justified for evaluating asymmetry. In addition, panoramic radiography and mandibular asymmetry have been used frequently for this purpose in the literature (Sezgin *et al.*, 2007; Halicioglu *et al.*, 2013; Abad-Santamaría *et al.*, 2014; Al Taki *et al.*, 2015; Kasimoglu *et al.*, 2015).

CONCLUSION

There was no statistically significant difference in condylar, ramal, and condylar-ramal asymmetry values between subjects who had a unilateral permanent first molar tooth extracted at an early age and the control group. Asymmetry index values were similar in both sexes. It can be said that unilateral mandibular permanent first molar tooth extraction does not have a negative effect on condyle development.

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RESUMEN: La simetría craneofacial es un factor importante para crear una apariencia facial armoniosa. Factores genéticos y externos pueden causar la formación de asimetría mandibular. El objetivo de este estudio fue evaluar las asimetrías mandibulares verticales en adolescentes a quienes se les extrajo el primer molar permanente (FPM) mandibular unilateral a una edad temprana. El grupo de estudio consistió en 60 sujetos (30 mujeres, 30 hombres con una edad media de 16,18±1,04 años) a quienes se les extrajo el primer molar mandibular permanente antes de los 12 años, y el grupo control consistió en 60 sujetos sanos (30 mujeres, 30 hombres con una edad media de 16,23±0,92 años). El índice de asimetría condilar (CAI), el índice de asimetría ramal (RAI) y el índice de asimetría condilar-ramal (CRAI) se calcularon utilizando radiografías panorámicas de los sujetos. Se utilizó la prueba t de muestras independientes para evaluar las diferencias entre los grupos. Los valores de CAI, RAI y CRAI fueron similares entre los hombres y las mujeres tanto en el grupo control como en el de estudio, y no se encontraron diferencias estadísticamente significativas ($p>0.05$). No se observaron diferencias estadísticamente significativas entre el grupo al que se le extrajo el primer molar permanente mandibular a una edad temprana y el grupo control ($p>0,05$). Los valores de CAI fueron relativamente más altos en ambos grupos, pero no hubo diferencias significativas entre los valores de CAI, RAI y CRAI entre los grupos.

PALABRAS CLAVE: Asimetría condilar; Asimetría mandibular; Radiografía panorámica; Extracción dental.

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Corresponding author:
Dr. Hayri Akman
Department of Pediatric Dentistry
Faculty of Dentistry
Alanya Alaaddin Keykubat University
07400 Antalya
TURKEY

E-mail: akmanhayri@gmail.com