Original Article

DOI: 10.14235/bas.galenos.2021.6329
Bezmialem Science 2022;10(3):319-24

Craniomandibular Asymmetry Evaluation of Patients with Eruption Disturbances of Second Molar Teeth

Sürme Bozukluğu Gösteren İkinci Molar Dişlere Sahip Hastalarda Kraniyomandibular Asimetri Değerlendirmesi

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ABSTRACT

Objective: The aim of this study was to evaluate craniomandibular asymmetry in patients with unilateral eruption disturbances of permanent second molar teeth.

Methods: Fifty-two patients showing unilateral eruption disturbances (delayed eruption and impaction) of permanent second molar teeth were included in the study group. Thirty patients with normally erupted second molar teeth were included in the control group. The gonial angle, length of condyle head, length of condyle neck, ramus height, corpus length, and angles between facial skeletal midline and transversal lines formed by connection of some important anatomical points on both sides were measured on orthopantomograms. Asymmetry indices were calculated for each parameter. Paired t-test was used in each group separately when comparing both sides of the face. Unpaired t-test was used when comparing study group and control group with regard to asymmetry index parameters.

Results: In study group; increases in gonial angle, length of condyle head, and ramus height were observed on the eruption disturbance side compared to the normally erupted side ($p<0.05$). Angles between facial skeletal midline and three separate lines formed by connection of articular eminence points, sigmoid notches, and gonion points were significantly higher on the normally erupted side. In control group, there was no statistically significant difference between both sides of the face. All asymmetry index parameters were showing statistically significant differences between study and control groups.

ÖZ

Amaç: Bu çalışmanın amacı daimi ikinci molar dişlerinde tek taraflı sürme bozukluğu gösteren hastalarda kraniyomandibular asimetri değerlendirmesi yapmaktı.

Yöntemler: Daimi ikinci molar dişlerinde tek taraflı sürme bozukluğu (gecikmiş sürme ve gömülü kalma) gösteren 52 hasta çalışma grubuna dahil edildi. Normal süren ikinci molar dişlere sahip 30 hasta kontrol grubuna dahil edildi. Gonial açı, kondil başı uzunluğu, kondil boynu uzunluğu, ramus uzunluğu, korpus uzunluğu ve yüzün her iki tarafındaki bazı önemli anatomik noktaların birleşmesiyle oluşan transvers çizgilerin yüz iskeletsel orta hattıyla yaptığı açılar panoramik film üzerinde ölçüldü. Her parametre için asimetri indeksi hesaplandı. Yüzün her iki tarafının birbirleriyle karşılaştırılmasında her bir grupta ayrı ayrı bağımlı örneklem t-testi kullanıldı. Asimetri indeksi parametreleri açısından çalışma grubu ve kontrol grubu karşılaştırılırken bağımsız örneklem t-testi kullanıldı.

Bulgular: Çalışma grubunda sürme bozukluğu olan tarafta normal sürme tarafına göre gonial açıda, kondil başı uzunluğunda ve ramus uzunluğunda artmış değerler gözlemlendi ($p<0,05$). Yüz iskeletsel orta hattı ile artiküler eminens noktalarının, sigmoid notch noktalarının ve gonion noktalarının oluşturduğu 3 ayrı doğru arasında kalan açılar normal sürme tarafında anlamlı derecede daha yüksekti. Kontrol grubunda, yüzün her iki tarafı arasında istatistiksel olarak anlamlı bir fark yoktu. Çalışma ve kontrol grupları arasında tüm asimetri indeks parametreleri anlamlı fark göstermekteydi.

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Cite this article as: Akbulut AS, Soğancı AE. Craniomandibular Asymmetry Evaluation of Patients with Eruption Disturbances of Second Molar Teeth. Bezmialem Science 2022;10(3):319-24

Received: 18.04.2021
Accepted: 02.09.2021

Conclusion: Through this retrospective study, eruption disturbances of permanent second molars could be associated with craniomandibular asymmetry.

Keywords: Facial asymmetry, molar, tooth eruption

Sonuç: Bu retrospektif çalışma doğrultusunda, daimi ikinci molarların sürme bozuklukları kraniyomandibular asimetri ile ilişkili olabilir.

Anahtar Sözcükler: Yüz asimetrisi, molar, diş sürmesi

Introduction

The goals of orthodontic treatment are not only to provide dental esthetics, functional occlusion, periodontal health, and stability but also to provide facial esthetics (1). Facial symmetry plays an important role in facial esthetics, which creates the perception of attractiveness. Craniofacial asymmetry is the non-matching of the right and left sides of the face based on the facial midline. Congenital problems such as a cleft lip and palate or hemifacial microsomia as well as environmental factors such as infection or trauma are only a few etiologic factors causing asymmetry of the face (2,3). Parafunctional habits and functional problems as well as dento-occlusal problems also lead to facial asymmetry (4,5). Recent studies have investigated the effect of dental factors such as unilateral tooth absence, early extraction of molar teeth, and a unilateral crossbite on craniofacial asymmetry (6-9). But more dental factors should be investigated for the early detection of craniofacial asymmetry and for an appropriate intervention time. In this way, treatment modalities can be developed, and preventive measures can be taken before severe asymmetry occurs.

On the other hand, dental clinicians confront various kinds of eruption disturbances in daily practice. These challenging problems include ankylosis, premature eruption, ectopic eruption, delayed eruption, over eruption, and impaction. Among these, delayed eruption is defined as the non-eruption of a tooth, even when the tooth has developed more than the root length expected for eruption (10), and impaction is described as non-eruption of a tooth due to a physical obstacle in the eruption path or the abnormal position of that tooth even when root completion has finished (11). Although third molars are the most common teeth showing eruption disturbances, increasing rates of second molar teeth with eruption disturbances are also remarkable (12-14). Since craniofacial asymmetry leads to an unaesthetic appearance, to disharmony of the maxillomandibular complex during dynamic movements, and to malocclusions, underlying dental factors should be investigated to prevent craniofacial asymmetry.

The purpose of this retrospective study was to evaluate the hypothesis that unilateral eruption disturbances such as impaction and the delayed eruption of permanent second molar teeth were associated with craniomandibular asymmetry.

Method

Necmettin Erbakan University, Faculty of Dentistry Ethics Committee approval was obtained for this retrospective study (decision no: 2019.07). Initial diagnostic records of 6,010 patients referred to the Department of Orthodontics, Faculty of Dentistry, Necmettin Erbakan University, between June 2015 and March 2019 were consecutively recruited.

Inclusion criteria for the study group were as follows: 1) patients showing delayed eruption or impaction of at least one second molar tooth on one side and normally erupted second molar teeth on the other side; and 2) patients older than twelve years of age. Inclusion criteria for control group were as follows: 1) patients showing full eruption of 28 teeth except for third molar teeth; and 2) patients older than nine years of age. For both the study and control groups, patients were excluded who had craniofacial anomalies, systemic disease, a trauma history to the head and face region, temporomandibular joint fractures or ankylosis, orthodontic treatment history, missing teeth except for third molars, tumors, or infection in the posterior region.

In total, 82 patients were included in this retrospective archive study. Fifty two patients and 30 patients were in the study group and the control group, respectively.

This study was comprised of two parts. The first part was to use a split-mouth design to compare craniomandibular structures between the eruption disturbance side of the second molar and the normally erupted side of the second molar. The second part was a comparison of craniomandibular structures between the study and control groups.

Measurement Method

All measurements were performed on initial panoramic radiographic images. Panoramic radiographic records were obtained using the same machine (Morita Veraviewepocs 3D R100-P, J Morita MFG Corp., Kyoto, Japan) at 70 kVp, 10mA, and 10 s, with a method standardized by the light beam sensor and the parallelism between the orbital plane and horizontal plane. Reliability and reproducibility were enabled by the autofocus feature of the machine. Measurements were performed using the same software to calibrate each image (Turcasoft Software Co., Ltd., Samsun, Turkey).

All measurements were performed by one examiner. For interexaminer reliability, 104 randomly selected measurements were repeated by another examiner.

On each panoramic radiograph, the orbital plane was determined as the line connecting the orbital points on both sides. A midline perpendicular to the orbital plane and passing through the anterior nasal spine was determined. The line connecting the articular eminence points was the articular eminence plane, the line connecting the sigmoid notches was the sigmoid notch plane, and the line connecting the gonion points was the gonion

plane. The angles of these three planes, with the midline on both the right and left sides, were measured. The angular parameters were as follows: Gonial angle (Gonial A°), articular eminence plane angle (AE-P°), sigmoid notch plane angle (Sg-P°), and gonion plane angle (Go-P°) (Figure 1).

The linear parameters were as follows: condyle head length (Co-CC), condyle neck length (CC-Sg), ramus height, and corpus length (Figure 2).

For comparisons of each parameter between the study and control groups, an asymmetry index was calculated for each parameter. The control group asymmetry index was calculated according to Habets' formula (15). For the study group, the formula was modified according to the values of the normally erupted side of the second molar and the eruption disturbance side of the second molar [(normally erupted side - eruption disturbance side)/(normally erupted side + eruption disturbance side) x100].

Statistical Analysis

The IBM SPSS Statistics Version 22.0 (Chicago, IL, USA) was used in all statistical analyses. Interexaminer reliability was determined with the Pearson correlation analysis. The data distribution of normality was decided by the Shapiro-Wilk test and the Kolmogorov-Smirnov test. In the study group, the comparison of craniomandibular structural parameters between the eruption disturbance side of the second molar and the normally erupted side of the second molar was analyzed with a paired samples t-test. In the control group, the comparison of the craniomandibular structural parameters between the right and left sides was determined by a paired samples t-test. The comparison of all asymmetry indices for each parameter between the study and control groups was evaluated with an unpaired t-test. The p-value was set at 0.05 for statistical significance.

Results

In total, 82 patients (51 female, 31 male, mean age: 14y-5m) were included in this retrospective archive study. The study group consisted of 52 patients (31 female, 21 male, mean age: 14y-7m), while the control group consisted of 30 patients (20 female, 10 male, mean age: 14y-1m).

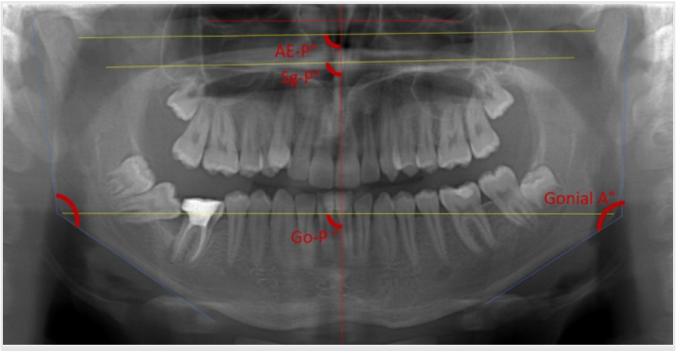

Figure 1. Angular measurements
Gonial Angle (Gonial A°), Articular Eminence Plane Angle (AE-P°), Sigmoid Notch Plane Angle (Sg-P°), Gonion Plane Angle (Go-P°)

According to the Shapiro-Wilk test and the Kolmogorov-Smirnov test, the data were normally distributed (p>0.05). Pearson correlation analysis showed 92% correlation between the measurements of the first and second examiners.

In the study group, AE-P°, Sg-P°, and Go-P° were statistically higher at the normally erupted side of the second molar. The ramus height, Co-CC, and Gonial A° were statistically higher at the eruption disturbance side of the second molar. CC-Sg and corpus length showed no statistical difference between the two sides (Table 1). In the control group, none of the measurements showed statistically significant differences between the right and left sides (Table 2).

The unpaired t-test showed that the index values of all parameters were statistically significantly higher for the study group when compared to the control group (p>0.05) (Table 3).

Discussion

Etiologic factors of the mandibulofacial asymmetries were reviewed in a previous study (16). That review highlighted the following as factors associated with mandibular and facial asymmetries: hemifacial microsomia, congenital hemifacial hypertrophy, hemifacial atrophy, Romberg syndrome, postural deformities such as torticollis and scoliosis, unilateral cranial synostosis, intrauterine pressure, endocrinal disorders, infectious disorders such as rheumatoid arthritis and arthritis associated with psoriasis, temporomandibular joint damage and injuries resulting in fractures and ankylosis, unilateral growth of the condyle, and dentofacial factors such as crossbite, and mandibular deviation. The current study only aimed to investigate the effect of the eruption process of molar teeth on facial asymmetry as a dental factor. Therefore, all above-mentioned factors were eliminated from the study sample with detailed anamnesis and radiologic examination.

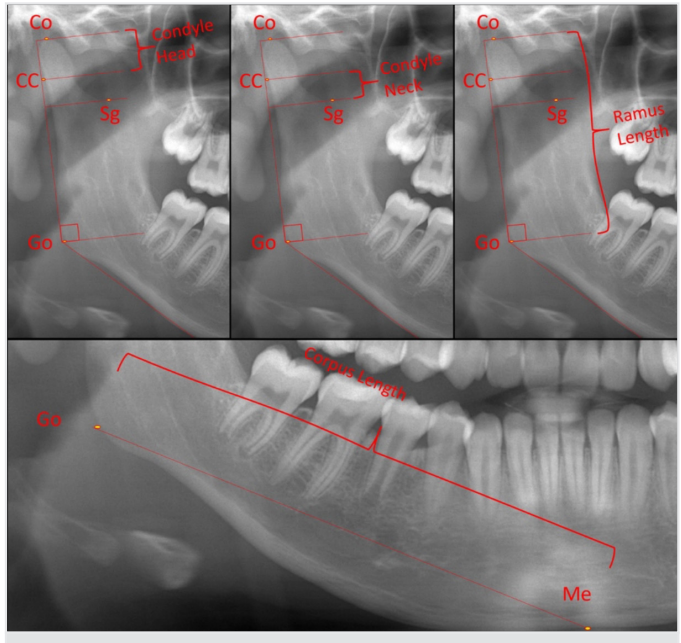

Figure 2. Linear measurements
Condyle Head Length (Co-CC), Condyle Neck Length (CC-Sg), Ramus height (Co-Go), Corpus Length (Go-Me)

Table 1. Comparison between erupted-side and eruption disturbance-side in study group

	Paired differences				
	Mean	SD	t	df	p
Erupted Side Gonial A◦ - Eruption Disturbance Side Gonial A◦	-2.03	3.81	-3.847	51	0.001*
Erupted Side AE-P◦ - Eruption Disturbance Side AE-P◦	0.94	2.40	2.826	51	0.007*
Erupted Side Sg-P◦ - Eruption Disturbance Side Sg-P◦	1.25	2.16	4.149	51	0.001*
Erupted Side Go-P◦ - Eruption Disturbance Side Go-P◦	1.03	2.47	3.021	51	0.004*
Erupted Side Co-CC - Eruption Disturbance Side Co-CC (mm)	-0.17	0.17	-7.288	51	0.001*
Erupted Side CC-Sg - Eruption Disturbance Side CC-Sg (mm)	-0.01	0.31	-.175	51	0.862
Erupted Side Ramus - Eruption Disturbance Side Ramus (mm)	-0.12	0.36	-2.334	51	0.024*
Erupted Side Corpus - Eruption Disturbance Side Corpus (mm)	0.05	0.76	0.430	51	0.669

*p<0.05
95% confidence interval.
SD: Standard deviation

Table 2. Comparison between right side and left side in control group

	Paired differences				
	Mean	SD	t	df	p
Erupted Side Gonial A◦ - Eruption Disturbance Side Gonial A◦	-0.05	0.54	-0.512	29	0.612
Erupted Side AE-P◦ - Eruption Disturbance Side AE-P◦	0.01	0.49	0.126	29	0.901
Erupted Side Sg-P◦ - Eruption Disturbance Side Sg-P◦	0.01	0.43	0.110	29	0.913
Erupted Side Go-P◦ - Eruption Disturbance Side Go-P◦	0.11	0.64	0.907	29	0.372
Erupted Side Co-CC - Eruption Disturbance Side Co-CC (mm)	0.02	0.07	1.668	29	0.106
Erupted Side CC-Sg - Eruption Disturbance Side CC-Sg (mm)	0.01	0.06	0.909	29	0.371
Erupted Side Ramus - Eruption Disturbance Side Ramus (mm)	0.00	0.10	0.037	29	0.971
Erupted Side Corpus - Eruption Disturbance Side Corpus (mm)	-0.01	0.21	-0.312	29	0.757

SD: Standard deviation

Table 3. Comparison of asymmetry indices between study group and control group

	Study group (n=52)		Control group (n=30)			
	Mean	SD	Mean	SD	t	p
Gonial index	1.32	1.116	0.16	.132	5.620	0.001*
AE-P index	1.01	1.001	0.15	.230	4.660	0.001*
Sg- P index	1.08	0.869	0.15	.182	5.736	0.001*
Go- P index	1.09	1.003	0.18	.310	4.835	0.001*
Co-CC index	7.04	5.644	2.65	2.183	4.071	0.001*
CC-Sg index	9.52	8.533	1.82	1.965	4.855	0.001*
Ramus index	1.93	1.761	0.51	.464	4.329	0.001*
Corpus index	2.56	2.106	0.74	.496	4.647	0.001*

*p<0.05
95% confidence interval.
SD: Standard deviation

Root formation stage was the main criteria on decision of tooth eruption status. However, chronological age was also considered in inclusion criteria. Although eruption age of second molar teeth is widely known as age 12, permanent molars' eruption age can show variations (17). Not only the authors' clinical experience but also the initial screening for sample collection referred to the existence of cases who completed the normal eruption process of second molar teeth even at age 9. Therefore, the subjects more than 9 years of age were included in the control group while the age more than 12 was determined for study group.

According to the present study, patients in the control group showed symmetry of craniomandibular structures on the left and right sides of the face. However, in the study group, only the corpus length and condyle neck were symmetric for both sides of the face. Patients in the study group showed a downward tilt of AE-P°, Sg-P°, and Go-P° from the normally erupted side to the eruption disturbance side. The condyle head and ramus were also longer at the eruption disturbance side, with an increased Gonial A°. Patients in the study group showed more asymmetric craniomandibular structures when compared with patients in the control group.

The authors believe that this study is the first to evaluate craniomandibular asymmetry in patients with unilateral eruption disturbances of the posterior teeth. In a previous study (7), condylar asymmetry in patients with unilateral second premolar teeth agenesis was investigated. Unlike the current study's findings, in the study group, the condylar, ramal, and total ramus heights showed no statistically significant difference on either side of the face. According to that study's findings, there was no statistical difference for the asymmetry index of the ramal height and total ramus height. However, a more asymmetric condyle in the study group, when compared with the control group, was consistent with the results of the current study. Another study (18) investigated the effects of early unilateral mandibular first molar extraction on condylar and ramal vertical asymmetry. There was no statistically significant difference in terms of the condylar, ramal and total ramus height between the sides of the face. But asymmetry indices showed asymmetry in only the total ramus height in the study group when compared with the control group. This finding correlated with the results of the present study.

The above-mentioned two studies showed no difference between the study groups with respect to both sides of the face. But in the current study, the length of the condyle head and the ramus height showed statistically significant differences in the study group for both sides of the face. This can be evaluated from different points of view. First, the current study included not only one tooth but also both the upper and lower teeth of the same side during the selection of unilateral eruption disturbances. These subjects could increase the severity of the asymmetry. Second, the above-mentioned studies were investigating agenesis or extraction, while in the current study sample, teeth were totally or partly present in the bone. This could directly affect the bone volume. On the other hand, the common point of these studies was that the nonfunction of a related tooth might lead to chewing on the ipsilateral side. In the current study, this chewing side preference was due to eruption problems, while in the above-mentioned studies, the absence of teeth was the main reason for the preference.

In a previous study, mandibular vertical measurements were performed by using the panoramic radiographs of patients with Class II subdivision and Class I occlusion (19). According to their results, Gonial A° and asymmetry indices for condyle height, ramus height, and condyle + ramus height showed no statistical difference between the study group (Class II subdivision) and the control group (Class I). Therefore, in the present study sample, the authors did not consider the malocclusion type even if it was diagnosed as Class II subdivision or Class III subdivision.

However, in another study, similar parameters were investigated in patients with a posterior crossbite, using a similar method (9). Since the authors concluded statistically higher indices for the group with a posterior crossbite than for the control group, crossbite was excluded from the current study sample to avoid the effect of dental crossbite on asymmetry.

According to the current study, Gonial A° was greater on the affected side. The epigenetic effects of second molar teeth's eruption on craniofacial growth and remodeling could be considered to explain these observations.

Slight degrees of asymmetry are acceptable in daily practice. However, to the authors' knowledge, there wasn't any research in the literature about asymmetry index values within normal ranges. Therefore, a comparison of asymmetry indices between the study group and the control group was performed to a more reliable method.

Study Limitations

A limitation of the present study was the nonexistence of specific exclusion criteria for the third molar teeth. Agenesis of third molars can be considered for further studies, to eliminate the effect of these teeth on the measurements, since they can affect the bone volume in the posterior region. Although all other teeth except for second molars and third molars were in a normal eruption state, it was impossible to check any previous delay at the eruption of these teeth in all patients. This can also affect the measurements.

Cone beam computed tomography images are effective in detecting craniofacial asymmetry. However, the sample was consisting of the patients who were admitted for initial examination. Therefore, panoramic radiographs that were obtained according to the ALARA principle were used in this retrospective study. There was an autofocus feature of the panoramic machine used in this study. The distance to the patient's teeth is measured by the light beam sensor and the arm moves into the optimal position automatically. This feature enables to have panoramic radiographs with a high degree of reproducibility and reliability. On the other hand, some authors have suggested excellent reliability for the total ramal height when panoramic radiographs are used (20). However, panoramic

radiography does not show as good a diagnostic value as for the total ramal height when compared with the asymmetry index of the condylar region. From an ethical perspective, although panoramic radiographs have commonly been used, due to their affordability and low doses of radiation, three-dimensional imaging techniques with a larger sample size may be useful to obtain more precise measurements in further studies.

Conclusion

In support of the authors' hypothesis, eruption disturbances of permanent second molar teeth could be associated with craniomandibular asymmetry. Regular examination of second molar eruption should be considered to prevent possible facial asymmetry of the patient.

Ethics

Ethics Committee Approval: Necmettin Erbakan University, Faculty of Dentistry Ethics Committee approval was obtained for this retrospective study (decision no: 2019.07).

Informed Consent: Retrospective study.

Peer-review: Externally peer reviewed.

Authorship Contributions

Concept: A.S.A., Design: A.S.A., Data Collection or Processing: A.S.A., A.E.S., Analysis or Interpretation: A.S.A., A.E.S., Literature Search: A.S.A., Writing: A.S.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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