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ORIGINAL ARTICLE

Is there a relationship between maxillary canine impaction and ocular asymmetry

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Abstract

Introduction Impacted maxillary canines may be in close proximity with related structures, such as the nasal cavity, orbital cavity, and maxillary sinus. The aim of this study was to evaluate the effects of unilateral maxillary canine impaction on ocular asymmetry. The null hypotheses were as follows: (1) there is no difference in the ocular location between the subjects with impacted canines and the control group; (2) there is no difference in the ocular location between the two sides of subjects with impacted canine.
Methods A total of 50 subjects with unilateral palatally impacted maxillary canines were selected as the study group, and 49 subjects without any impacted teeth were selected as controls. Ocular asymmetry was evaluated on standardized frontal photographs of the subjects in both groups, and the results were statistically compared.
Results Unilateral impaction of maxillary canines did not have a statistically significant effect on the vertical ocular location, nor did maxillary canine impaction affect the horizontal ocular location on either side of the face within the impacted canine group. There was a statistically significant difference in the horizontal ocular location between the impacted canine group and the control group. Gender differences did not have an effect on the ocular location in either of the study groups.
Conclusions Both hypotheses were accepted. A relationship between the impacted maxillary canine and ocular asymmetry could not be demonstrated.

Keywords Cuspid · Impacted canine teeth · Eye asymmetry · Facial asymmetry · Esthetics

Besteht ein Zusammenhang zwischen Impaktion des oberen Eckzahns und Asymmetrie der Augen

Zusammenfassung

Einführung Impaktierte Oberkiefereckzähne können sich in unmittelbarer Nähe zu benachbarten Strukturen befinden, etwa zur Nasenhöhle, zur Augenhöhle und zum Sinus maxillaris. Ziel dieser Studie war es, die Auswirkungen einer einseitigen Impaktion des oberen Eckzahnes auf die Symmetrie der Augen zu untersuchen. Die Nullhypothesen waren wie folgt: (1) Es gibt keinen Unterschied in der okulären Position zwischen den Probanden mit impaktierten Eckzähnen und der Kontrollgruppe; (2) es gibt keinen Unterschied in der okulären Position zwischen den beiden Seiten der Probanden mit impaktierten Eckzähnen.
Methoden Insgesamt 50 Probanden mit einseitig palatinal impaktierten Oberkiefereckzähnen bildeten die Studiengruppe, und 49 Probanden ohne impaktierte Zähne wurden als Kontrollen ausgewählt. Die okuläre Asymmetrie wurde an standardisierten Frontalfotos der Probanden beider Gruppen ausgewertet, und die Ergebnisse wurden statistisch evaluiert.

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Ergebnisse Die Impaktion eines oberen Eckzahnes hatte keinen statistisch signifikanten Einfluss auf die vertikale Augenposition. Sie hatte auch keinen Einfluss auf die horizontale okuläre Position auf beiden Seiten des Gesichts innerhalb der Gruppe mit impaktiertem Eckzahn. Es gab einen statistisch signifikanten Unterschied in der horizontalen okulären Position zwischen der Gruppe mit Impaktion und der Kontrollgruppe. Geschlechtsbezogene Unterschiede zeigten in beiden Gruppen keinen Einfluss auf die Augenposition.

Schlussfolgerungen Beide Hypothesen wurden akzeptiert. Ein Zusammenhang zwischen einseitig impaktierten Oberkieferereckzähnen und Augenasymmetrien konnte nicht nachgewiesen werden.

Schlüsselwörter Eckzahn · Impaktierte Eckzähne · Augenasymmetrie · Gesichtsasymmetrie · Ästhetik

Introduction

Facial esthetics is one of the main goals of orthodontics [16]. While exact facial symmetry is defined as the state in which one side of the face completely reflects the other side, reports of minor asymmetries are commonly [14, 16].

The eyes are the main focal point of the face and generally affect the overall impression of a person's character and aspect. However, many people are unaware of facial and ocular asymmetry [20]. Knowledge of asymmetry and normal orbital development is desired in clinical practice to understand pathologies or delayed development [15].

The relation of tooth absence with facial asymmetry is not well documented in the literature. A few studies have investigated the relationship between facial asymmetry and tooth absence [3, 8, 9, 13, 17, 19]. In orthodontics, impacted teeth are a major concern, as well as tooth agenesis. Maxillary canines are the second most frequently impacted teeth after wisdom teeth. Permanent canines are generally known as "eye teeth" as they develop directly below the floor of the orbitae [21]. A total of 85% of palatally impacted permanent canines (PIPCs) are reported to be embedded palatally [1], and 69.4% of PIPCs are reported to be embedded unilaterally [6]. PIPCs can be in close proximity with the maxillary sinus and the floor of the nose [12].

To the best of our knowledge, this is the first study evaluating the possible relation between maxillary canine impaction and ocular asymmetry.

The null hypotheses of the present study are as follows:

- There is no difference in the ocular location between the subjects with impacted canine and the control group.
- There is no difference in the ocular location between the two sides of subjects with impacted canine.

Materials and methods

This study was approved by the Istanbul Medipol University Ethics Committee (study number: 2018/497).

For the study group were selected: 50 patients (24 males, 26 females; age 15–19 years) with a class I malocclusion and a unilateral palatal impacted maxillary canine.

Selected for the control group were 49 patients (25 males, 24 females; age 15–19 years) with a class I malocclusion with normal dentition without impaction.

For both groups the selection was based on the availability of pretreatment records in our clinic and a set of additional exclusion/inclusion criteria. Thus, standardized frontal facial photographs of the subjects taken by the same researcher (GS) in a photography room while their heads were in natural position, looking into the lens of the camera, with teeth in occlusion and face and lips relaxed. The same researcher took all of the photographs under the same technical and environmental conditions using the same camera with the same settings.

The exclusion criteria for both groups were the following: visible dental or myofacial asymmetries; clinically visible eye anomalies and any type of eye pathology or surgery that has been stated in the medical history; craniofacial anomalies; temporomandibular disorders; having multiple impacted teeth and one impacted maxillary canine; hypodontia; or nasal and sinus anomalies.

The inclusion criteria for the study group were the following: one-sided maxillary palatally impacted canine regardless of its position in the alveolus with no space on the maxillary arch to erupt (as determined in the orthopantomograms and occlusal radiographs); Angle class I malocclusion with the other permanent teeth erupted and present in the mouth; and no previous orthodontic treatment.

The inclusion criteria for the control group were Angle class I malocclusion with all permanent teeth erupted and present in the mouth. No previous orthodontic treatment.

The condition of the third molars were neglected in the selection procedure for both groups. Based on the inclusion criteria, the material was collected from our clinical patient database.

The measurement procedure was as follows:

The researcher (DDK) who examined the asymmetry on the photographs was blinded to both the impaction side and the study groups. Apple Keynote Software (Apple Inc., Cupertino, CA, USA) was used to investigate the ocular asymmetry on the photographs by using the landmarks, lines and angles shown in Fig. 1. A mid-sagittal vertical line (G-Sn) was drawn passing through glabella (G) and subnasale (Sn)

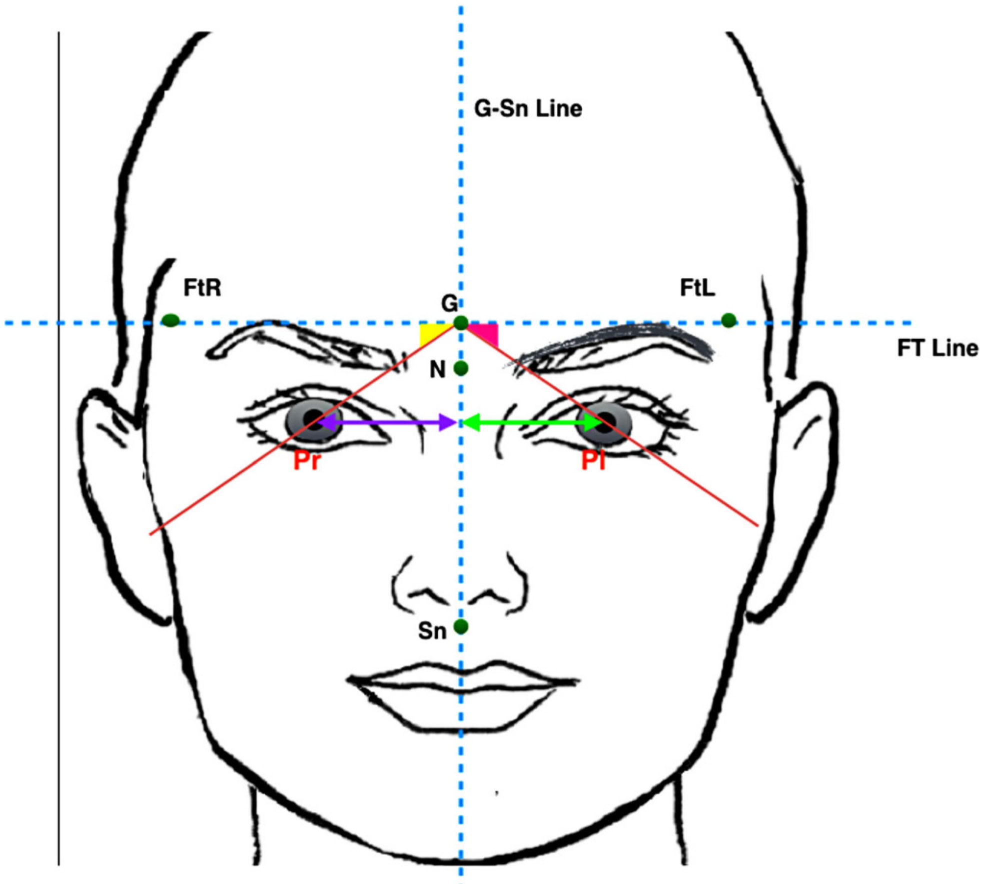

Fig. 1 Landmarks, lines and angles used in the study. Soft tissue landmarks: *FtR* frontotemporale right, *FtL* frontotemporale left, *G* glabella, *N* nasion soft, *Pr* right pupil, *Pl* left pupil, *Sn* subnasale. Lines: *G-Sn* glabella-subnasale midsagittal vertical reference line (*vertical dashed blue line*), *FT* frontotemporale horizontal reference line (*horizontal dashed blue line*). Angles: FtR-G-Pr (*yellow triangle*); FtL-G-Pl (*pink triangle*). Pupil right (Pr) to G-Sn distance (*purple double arrow*). Pupil left (Pl) to G-Sn distance (*green double arrow*)

Abb. 1 In der Studie verwendete Landmarken/Referenzpunkte, Linien und Winkel. Weichteillandmarken: *FtR* Frontotemporale rechts, *FtL* Frontotemporale links, *G* Glabella, *N* Nasion (i.O. "Weichteilnasion"), *Pr* rechte Pupille, *Pl* linke Pupille, *Sn* Subnasale. Linien: *G-Sn* Glabella-Subnasale mittsagittale vertikale Referenzlinie (*vertikale gestrichelte blaue Linie*), *FT* frontotemporale horizontale Referenzlinie (*vertikale gestrichelte blaue Linie*). Winkel: FtR-G-Pr (*gelbes Dreieck*); FtL-G-Pl (*pinkes Dreieck*). Pupille rechts (Pr) bis G-Sn-Distanz (*violetter Doppelpfeil*) Pupille links (Pl) bis G-Sn-Distanz (*grüner Doppelpfeil*)

points of the subject. Then, a horizontal supraorbital line (FT) passing above the eyebrows from the frontotemporal right point (FtR) to the frontotemporal left point (FtL) was drawn perpendicular to the G-Sn line. For evaluation of the horizontal ocular asymmetry, the linear distances between the pupils of the left (Pl) and right eyes (Pr) and the G-Sn vertical reference line were measured for both sides. The results of calculations are expressed as *closer* (the pupil was closer to the midline with respect to the opposite side), *farther* (the pupil was farther from the midline with respect to the opposite side) and *same* (the pupil was at the same distance to the midline with respect to the opposite side) to avoid possible errors in calibration of the photographs. For the evaluation of vertical ocular asymmetry, the two angles between the FT line and the pupils of the eyes on both sides (FT line-G-Pr and FT line-G-Pl) were calculated. A greater value of this angle indicated a lower vertical ocular level with respect to the other side.

Statistical methods

The measurements of 20 randomly selected subjects from each group were repeated by the same researcher within 2-week intervals to test intraobserver reliability. The method error was calculated, and the coefficient of reliability was found to be 0.92 using Houston's formula [10]. The results were evaluated with 95% confidence intervals (CIs), and the significance level was set at $p<0.05$. With a statistical power of 0.80, a sample size including 45 subjects for each group was required for the present study. There were 50 subjects enrolled in the impacted canine group and 49 subjects in the control group in this study.

The data were analyzed using IBM SPSS (V23.0 IBM Corp., Armonk, NY, USA). The normal distribution of the data was determined with the Shapiro–Wilk's test. Independent samples t-tests and dependent samples t-tests were used to compare normally distributed data. In the analysis of categorical data, the chi square (χ^2) test was used. The results are presented as the mean ± standard deviation (SD) and frequency (percent). The level of significance was taken as $p<0.05$.

Results

The difference between the mean values of the right and left angles of the subjects with a right impacted canine and left impacted canine were not statistically different ($p=0.503$, $p=0.444$ respectively). The mean value of the left angle was higher in the subjects with a left impacted canine ($p=0.032$). There was no statistical difference between the right angle mean values according to the side of impaction ($p=0.067$; Table 1).

There was no statistical difference between the right angle mean values and left angle mean values in both impacted canine group and control group ($p>0.05$; Table 2).

The horizontal distance between the pupil and midline was not dependent on the impaction side in the subjects with impacted canines ($p=0.089$; Table 3).

Left pupil to midline distance values ($p=0.040$) and right pupil to midline distance values were significantly different between the groups ($p=0.017$; Table 4).

Table 1 Comparison of the right and the left angle values according to the side of impaction
Tab. 1 Vergleich der linken und rechten Winkelwerte nach der von der Impaktion betroffenen Seite

Side of impaction	Left angle (FtL-G-Pl) Mean ± SD	Right angle (FtR-G-Pr) Mean ± SD	*p* value
Right (*n* = 28)	39.4 ± 3.9	39.0 ± 4.0	0.503
Left (*n* = 22)	41.9 ± 4.0	41.2 ± 4.6	0.444
p value	0.032	0.067	–

SD standard deviation. See Fig. 1 for other abbreviations

Table 2 Comparison of the right and the left angle values according to groups
Tab. 2 Vergleich der linken und rechten Winkelwerte nach Gruppen

	Left angle (FtL-G-Pl) Mean ± SD	Right angle (FtR-G-Pr) Mean ± SD	*p* value
Impacted canine group	40.5 ± 4.1	40.0 ± 4.3	0.301
Control group	40.9 ± 4.5	40.5 ± 3.5	0.336
p value	0.664	0.489	–

SD standard deviation. See Fig. 1 for other abbreviations

There was no statistical difference between the mean values of the left angle according to gender in the impacted canine group ($p=0.223$). Likewise, there was no statistical difference between the mean values of the right angle according to gender in the same group ($p=0.118$). In the control group, there was no statistical difference between the

Table 3 Comparison of pupil distances to the midline according to the side of impaction in the impacted canine group
Tab. 3 Vergleich der Pupillenabstände zur Mittellinie je nach von der Impaktion betroffenen Seite in der Gruppe mit impaktiertem Eckzahn

	Side of impaction		*p* value
	Right impacted canine group (*n* = 28) *n* (%)	Left impacted canine group (*n* = 22) *n* (%)	
Left pupil distance to the midline			
Closer to the midline (*n* = 27)	16 (57.1)	11 (50.0)	0.089
At the same distance with right pupil to the midline (*n* = 7)	6 (21.4)	1 (4.5)	–
Farther from the midline (*n* = 16)	6 (21.4)	10 (45.5)	
Right pupil distance to the midline			
Closer to the midline (*n* = 16)	6 (21.4)	10 (45.5)	0.089
At the same distance with left pupil to the midline (*n* = 7)	6 (21.4)	1 (4.5)	–
Farther from the midline (*n* = 27)	16 (57.1)	11 (50.0)	

Table 4 Comparison of left and right pupil distances to the midline according to the groups
Tab. 4 Abstände der linken und rechten Pupille zur Mittellinie, Intergruppenvergleich

Pupil distance to the midline	Impacted canine group *n* (%)	Control group *n* (%)	*p* value
Left pupil			
Closer to the midline (*n* = 44)	27 (54)	17 (34.7)	0.040
At the same distance with right pupil to the midline (*n* = 26)	7 (14)	19 (38.8)	–
Farther from the midline (*n* = 29)	16 (32)	13 (26.5)	
Right pupil			
Closer to the midline (*n* = 29)	16 (32)	13 (26.5)	0.017
At the same distance with left pupil to the midline (*n* = 26)	7 (14)	19 (38.8)	–
Farther from the midline (*n* = 44)	27 (54)	17 (34.7)	

Table 5 Comparison of angle values according to gender
Tab. 5 Vergleich der Winkelwerte nach Geschlecht

Group	Angle	Male	Female	*p* value
Impacted canine group	Left angle (FtL to Pl) Mean ± SD	39.8 ± 3.6	41.2 ± 4.5	0.223
	Right angle (FtR to Pr) Mean ± SD	39.0 ± 3.5	40.9 ± 4.9	0.118
Control group	Left angle (FtL to Pl) Mean ± SD	40.4 ± 5.0	41.5 ± 3.9	0.386
	Right Angle (FtR to Pr) Mean ± SD	40.1 ± 4.0	41.0 ± 2.8	0.426

SD standard deviation. See Fig. 1 for other abbreviations

mean values of the left angle ($p=0.386$) and mean values of the right angle according to gender ($p=0.426$; Table 5).

Discussion

Dental asymmetries are usually not considered the main reason for facial asymmetry, but they may affect facial harmony in some situations [2, 18]. Facial symmetry is formed by the harmony of many anatomical structures, such as the eyes, nose, lips, teeth, and jaws [5, 22].

Asymmetries of the eyes can affect general facial esthetics [20]. Evaluation of the ocular orbits is valuable in clinical practice. Morphometric examination of the orbits can include measurements of surface area, angles, length, volume, and curvature [4, 11, 23, 24]. Yi and Jang [23] calculated the distances "from the midpoint of the interpupil line to the most prominent malar point and the distance of the lip margin to the mandible angle" to examine the horizontal dimensions of the face and compared the results with those on the contralateral side to determine horizontal asymmetry. They expressed their findings in ratios. Seiji et al. [15] and Rossi et al. [14] presented the asymmetry between the left and right orbits as percentage rates. In our study, we also measured the distances from the pupils to the midline on both sides to evaluate the horizontal asymmetry, and we expressed our findings as *"closer to the midline (closer)", "farther from the midline (farther)"* and *"at the same distance from the midline (same)"* to avoid possible errors in the photographs.

We found that pupil–midline distance value was not dependent on the impaction side in subjects with impacted canine. However, the right and left pupil–midline distance values of the subjects with impacted canine were statistically different from the right and left pupil–midline distance values of control group.

Lepich et al. [11] measured the distance between the geometric centers of the left and right orbital cavities and the frontal median reference line. In the same study, they also measured the angles formed between the frontal median line and the geometric centers of orbits of dry skulls to evaluate the orbital asymmetry and reported orbital asymmetry in both genders.

In accordance with those results, we found that gender did not have an effect on the ocular location in either the impacted canine group or the control group.

Choi [5] stated that linear measurement from the median reference line to the same points on both sides of the face could be used for the analysis of the horizontal facial component. Hafezi et al. [7] found that transversal measurements were more significant than vertical measurements in the detection of facial asymmetry. Seiji et al. [15] found orbital asymmetry almost in all of the skull samples of their study, whereas Chebib and Chamma [4] did not find asymmetries in the orbital zones. Approximately 2–4% of metric percentage differences are accepted as a normal pattern in orbital asymmetries [3].

In our study, the impaction of a canine tooth did not have a statistically significant effect on the vertical ocular location. Similarly, no statistically significant difference was found in the vertical ocular location between the subjects with impacted canines and the control subjects. It could be concluded that a relationship between the impaction of a maxillary canine and ocular asymmetry could not be demonstrated. Nonetheless, there was no exact ocular symmetry, neither in the canine impaction group nor in the control group.

The limitation of our study was that it was carried out using a two-dimensional photographic method. Further research is required with three-dimensional (3D) radiographic and 3D photographic examination methods.

Conclusions

- There was no difference in the ocular location between the subjects with impacted canines and the control group.
- There was no difference in the ocular location between the two sides of the subjects with impacted canines.

Thus, both hypotheses of the study were accepted.

Conflict of interest D.D. Kılınç and G. Sayar declare that they have no competing interests.

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