

PREVALENCE OF IMPACTED CANINES IN ORTHODONTIC PATIENTS – A RADIOGRAPHIC STUDY

SHORT TITLE: PREVALENCE OF IMPACTED CANINES

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ABSTRACT

Objectives: The aim of this study was to assess the prevalence of impacted canines among the orthodontic patients, and to examine the distribution of impactions in relation to gender (male vs. female), affected jaw (upper vs. lower), type of impaction (unilateral vs. bilateral) and affected side of the jaw (right vs. left).

Materials and Methods: This cross-sectional study was conducted using digital panoramic radiographs of 3432 patients (1467 males and 1965 females) who attended the Department of Orthodontics, University of Sarajevo – Faculty of Dentistry with Dental Clinical Center. The radiographs were screened to determine the position of the canines, its angulation and relationship with adjacent teeth and surrounding structures. All data were analyzed using descriptive statistics, and differences between categorical variables, (such as gender /male and female/, affected jaw /upper vs. lower/, type of impaction/unilateral vs. bilateral/, and affected side of the jaw /right vs. left/) were tested using the chi-squared and Z-test.

Results: In the sample of orthodontic patients, impacted canines were found in 3.82% subjects. The prevalence was higher in females (2.24%) compared to males (1.57%). The majority of the impacted canines were unilateral (3.29%) compared to bilateral (0.52%). The ratio of maxillary to mandibular impaction was 17.714:1 in favor of maxillary impactions.

Conclusion: Impacted canines were found in 131 out of 3432 patients (3.82%). Females (2.24%) demonstrated a higher impaction rate than males (1.57%). However, the difference was not statistically significant.

Key words: prevalence, impaction, impacted canines, orthopantomogram, orthodontics

Introduction

Canines are teeth that, primarily due to their position in the dental arch, play an important role, anatomically and functionally, as well as aesthetically. Consequently, their absence represents a significant orthodontic problem, which requires adequate and timely therapy, and often an interdisciplinary approach in treatment [1,2].

An impacted tooth can be defined as a tooth with in which, after the end of normal growth and development, the eruption was partially or completely absent [3,4]. In relation to this, a canine is considered impacted when it has not erupted after the completion of root development or 6 or more months have passed since the eruption of the contralateral canine [5].

Due to a complex sequence of events in the eruption of canines, especially because of their very long eruptive path, it is assumed that canines have a greater chance of “detouring” [6]. Factors leading to this orthodontic anomaly can generally be divided into three etiological groups: local, systemic and genetic factors. In most cases, impaction is caused by local factors such as lack of space, absence of the maxillary lateral incisor, and prolonged retention or early loss of primary teeth [7,8]. In line with this, the presence of a persistent primary canine has been highlighted as a particularly important factor contributing to the increased risk of permanent canine impaction [9]. When it comes to palatally displaced maxillary canines, some authors favor the guidance theory, and others the genetic theory [10].

Impacted teeth can lead to some severe complications, primarily regarding root resorption of lateral or central incisors, but can also cause development of infections, cystic lesions and tumors [11].

The prevalence of impacted canines has been investigated in many different communities and ethnic groups, and the results are presented in various studies. Canines are found to be the second most impacted teeth in the oral cavity, right after third molars. The reported canine impaction rates range from 1% to 2.5%, taking into consideration both dental arches [2]. It should be noted that the

prevalence of canine impaction is much more common in the maxilla. Therefore, the research on the prevalence of canine impaction so far has focused more on maxillary than mandibular canines. Statistically, maxillary canines are affected by impaction approximately 20 times more often [12], with rates from 0.27% in Japanese population, to 6.04% in Mexico [13,14]. On the contrary, mandibular canine impaction rates range from 0.07% among the population of Hong Kong, to 1.7% in Italy [12,15].

Additionally, research studies show a higher prevalence of unilateral impaction, as well as an approximately 8:1 ratio in favor of palatal maxillary impaction, comparing to buccal. Gender differences in the prevalence of canine impaction have also been reviewed, suggesting that females are more affected than males [10]. In regions where systematic interceptive orthodontic treatment has been implemented, the prevalence of impacted maxillary canines has been found to be lower compared to previously reported data [16].

Given that the condition is asymptomatic in most cases, it is usually detected accidentally during a routine dental examination or on panoramic images. The first step to a diagnosis is a clinical examination and evaluation, which should include visual inspection and palpation to assess the position of the canine in the alveoli. A great emphasis is placed on palpating the buccal prominence, ideally in the ninth year of life [17]. It is necessary to complete the diagnostic procedure with radiographic examination, to get a better insight into the position and angulation of the impacted tooth. Currently, panoramic radiographs are the most used type of imaging, and take a mandatory part in the diagnostic protocol in orthodontics [18]. Using radiographic images, impacted canines can be classified according to their position in relation to the occlusal plane and their angulation to the midline of teeth [2].

Consequently, impacted canines can be classified as vertically and horizontally impacted, with mesial or distal crown inclinations [19].

The aim of this study was to assess the prevalence of impacted canines among a group of orthodontic patients, since no similar studies have been conducted in Bosnia and Herzegovina.

Materials and methods:

Ethical approval and consent

This study received approval from the Ethics Committee of the Faculty of Dentistry with Dental Clinical Centre, University of Sarajevo, number: 02-3-4-19-1-5/2024, dated 24.01.2024. The patients have previously consented that their data and radiographs could be used for research and education purposes.

Data and sample collection

A cross sectional study of 3432 digital panoramic radiographs - orthopantomograms (OPGs) was conducted using data from the files of the Department of Orthodontics, University of Sarajevo – Faculty of Dentistry with Dental Clinical Center, from January 2022 to December 2023. The total of 3432 recordings included 1965 OPG images of female patients, and 1467 OPG images of male patients. While reviewing the database, technically defective and repeated recordings were excluded beforehand. The aim of reviewing the database was to assess the prevalence of impacted teeth and their radiographic characteristics. On the other hand, demographic details, such as patients' age, gender, and treatment, were obtained from their dental records.

Inclusion criteria

This study included all patients who needed orthodontic treatment, and whose diagnostic protocol included panoramic radiographs, which were analyzed for the purpose of this study. Only clear OPG images with high quality were analyzed, which demanded good visibility of certain anatomic structures and completed root formation of impacted teeth. All patients included in this study were of Bosnian and Herzegovinian origin.

Exclusion criteria

After the initial analysis, 271 OPG images with an incorrect position of the maxillary and/or mandibular canines, were selected. In order to definitively confirm the diagnosis of canine impaction, medical/dental documentation (dental records) and Cone Beam Computed Tomography

(CBCT) images were obtained and additionally analyzed. All patients who were undergoing or had previously received orthodontic treatment (a total of 15), were excluded from this sample. Another 125 patients were excluded due to the following criteria: patient age below 12, incomplete documentation (lack of additional OPG images to confirm the diagnosis), patients with syndromes or general development disorders (such as cleft lip, alveolar ridge and/or palate).

Radiographic analysis

Every OPG image was analyzed for the position of the maxillary and mandibular canines, their angulation in relation to the occlusal plane, and their relationship with adjacent teeth.

Impaction was diagnosed when the eruption was completely absent, in a patient with permanent dentition and completed roots of all teeth. The overall prevalence of impacted canines was studied, as well as the pattern of their occurrence regarding the gender (male vs. female), affected jaw (upper vs. lower), type of impaction (unilateral vs. bilateral) and affected side of the jaw (right vs. left). All analysis of panoramic radiographs was supervised by an orthodontic specialist.

Statistical analysis

The collected data was processed in MS Excel and analyzed using descriptive statistics.

Statistical analysis was done with the help of the Pandas and SciPy libraries in the Python programming language, within the PyCharm environment. Differences in the distribution of impaction between the genders were analyzed using the Z-test.

A Chi-square test for independence was conducted to examine the association between categorical variables, such as upper/lower; unilateral/bilateral and right/left impaction. The level of significance was set at $p < 0.05$ for all tests. The research results were presented graphically.

Results

In the sample of 3432 digital panoramic radiographs of orthodontic patients, there were 1467

(42.74%) males and 1965 (57.26%) females. From the total of 3432 selected and analyzed radiographs, impaction was found in 131 (3.82%) subjects, among which 54 (1.57%) were male, and 77 (2.24%) were female subjects (Figure 1). There was no statistically significant difference between the genders (Z-value: 0.376; p-value: 0.353; $p > 0.05$). (Table 1)

Figure 2 shows the data on the presence of impacted canines in relation to jaws. In the upper jaw, the diagnosis of canine impaction was confirmed in 124 (3.61%) subjects, among which 48 (1.39%) were males and 76 (2.21%) were females. The appearance of canine impaction in the lower jaw was found in only 7 (0.20%) subjects, thereby including 5 (0.15%) male, and 2 (0.05%) female subjects. The difference between the upper and lower jaw impaction was statistically significant (p -value < 0.0001 ; $p < 0.05$), in favor of a more frequent impaction in the upper jaw (Table 2). However, there was no statistically significant difference between the genders neither with maxillary (Z-value: 0.964; p-value: 0.168; $p > 0.05$) nor with the mandibular canine impactions (Z-value: 1.6; p-value: 0.218; $p > 0.05$).

Unilateral canine impaction was more often than bilateral, and in this sample was found in 113 (3.29%) subjects (1.39% males and 1.89% females). However, bilateral canine impaction appeared in 18 (0.52%) subjects (0.17% males and 0.35% females) (Figure 2). The difference between the appearance of unilateral or bilateral canine impaction had a statistically significant value (p -value < 0.0001 ; $p < 0.05$), while the gender distribution for both unilateral (Z-value: 0.069; p-value: 0.472; $p > 0.05$) and bilateral (Z-value: 0.83; p-value: 0.402; $p > 0.05$) canine impaction was not statistically significant (Table 3).

From 113 unilateral impactions in this sample, 106 (3.09%) of them were found in the upper jaw, and 7 (0.20%) were found in the lower jaw. The difference was statistically significant (p -value < 0.0001 ; $p < 0.05$).

All of the bilateral canine impactions in this sample were diagnosed in the upper jaw. Figure 3 shows the data on the presence of unilateral canine impaction in relation to the right or left side of the jaw. Canine impaction on the left side of the jaw was found in 60 (1.75%) patients, among which 26

Figure 1.
Frequency of canine impaction according to gender

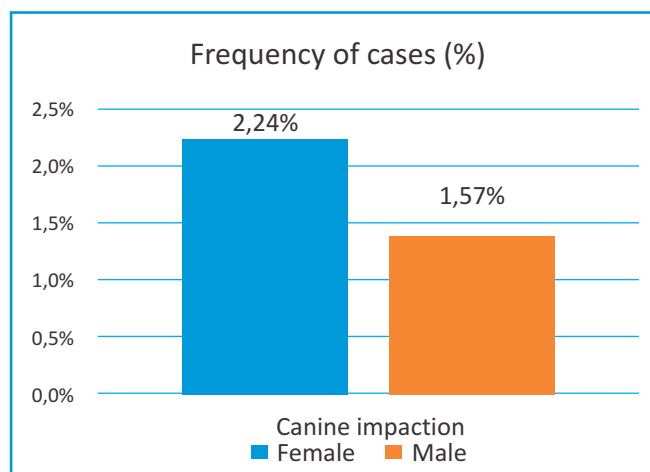


Table 1.
Prevalence of impacted canines among males and females

	Total number of impacted cases	Prevalence of impacted canines	P - value
Females with impacted canine	77	2.24%	p = 0.353
Males with impacted canine	54	1.57%	
Subjects with impacted canine	131	3.82%	

* $p > 0.05$, Statistically not – significant

Figure 2.
Frequency of canine impaction according to jaw, type of impaction and gender

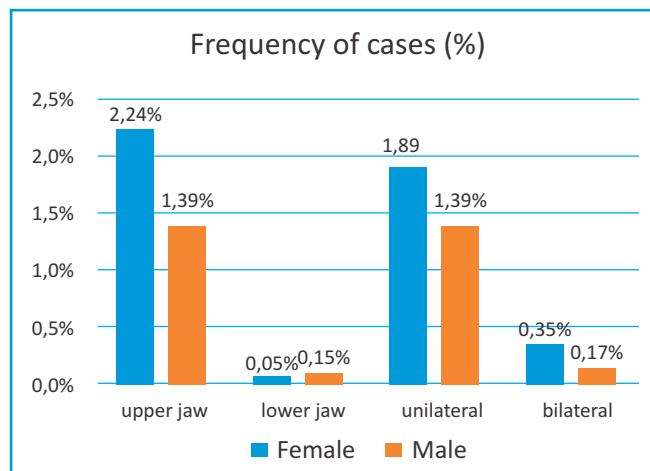


Table 2.
Percentage distribution of impacted canines
in the upper and lower jaw

	Frequency	Percentage	Prevalence	P - value
Upper jaw	124	94.66%	3.61%	p < 0.0001*
Lower jaw	7	5.34%	0.20%	
Total	131	100.0%	3.82%	

*p > 0.05, Statistically significant

Figure 3.
Frequency of canine impaction
according to affected side and gender

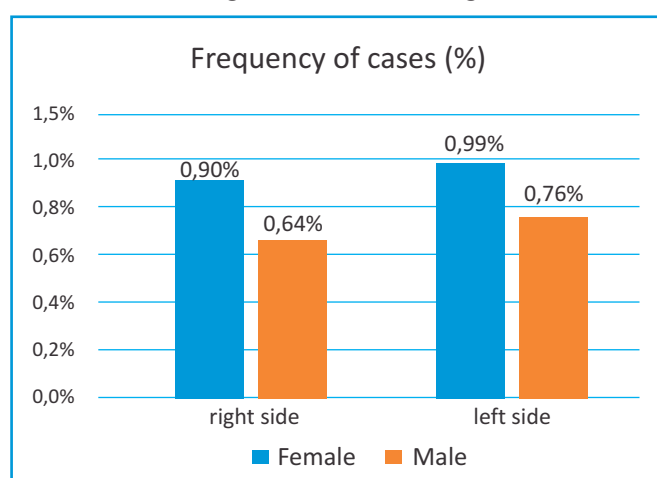


Table 3.
Frequency distribution of type of impaction

	Frequency	Percentage	Prevalence	P - value
Unilateral	113	86.26%	3.29%	p < 0.0001*
Bilateral	18	13.74%	0.52%	
Total	131	100.0%	3.82%	

*p > 0.05, Statistically significant

Table 4.
Association of gender with affected side (right vs. left)
and type of impaction (unilateral vs. bilateral)

Gender	Type of impactions		
	Right	Left	Bilateral
Male	22 (0.64%)	26 (0.76%)	6 (0.17%)
Female	31 (0.90%)	34 (0.99%)	12 (0.35%)
Total	53 (1.54%)	60 (1.75%)	18 (0.52%)

*p > 0.05, Statistically significant

(0.76%) were male and 34 (0.99%) were female subjects. On the right side of the jaw, unilateral canine impaction was diagnosed in 53 patients (1.54%), including thereby 22 (0.64%) male and 31 (0.90%) female subjects (Table 4). In this case, the difference between impactions on the right or left side of the jaw was not statistically significant (p-value: 0.512; p > 0.05). Similarly, there was no statistically significant difference between the genders, when it comes to impactions on the right (Z-value: 0.918; p-value: 0.421; p > 0.05) and left (Z-value: 0.091; p-value: 0.464; p > 0.05) side of the jaw.

Discussion

The findings of this cross sectional study provide valuable insights into the prevalence of impacted canines in the study population of Bosnia and Herzegovina, along with information on impaction distribution in relation to gender, jaw and other variables.

The results of this study showed that out of 3432 analyzed digital panoramic radiographs (OPG images) of orthodontic patients, 131 of them had one or more impacted canines. The resulting number indicated a prevalence of impacted canines of 3.82% among orthodontic patients from 2022 and 2023.

Due to similar values, this data can primarily be compared with results conducted on the population of Northern Cyprus in 2014, which show a slightly lower prevalence of canine impaction - 3.53% [20].

The reported prevalence of maxillary canine impaction varies from 0.27% to 6.04% [13,14]. The results of our study suggested a prevalence of maxillary canine impaction of approximately 3.61%, which is in accordance with previous, similar investigations. These results are in agreement with results of the study presented in 2010 by Greek and Turkish authors, who, based on a review of the available literature published up to 2010, found a prevalence of maxillary canine impaction ranging from 0.8 to 5.2% [10].

It should not be overlooked that the ethnic background of a particular sample may result in a higher or lower prevalence. In addition, possible differences in data caused by different

methodologies, sample sizes, and selection of respondents should always be taken into consideration.

When it comes to mandibular canines, the prevalence of their impaction in our sample was 0.20%, which is fully consistent with the currently available data. It can be considered to be the lowest prevalence, if we exclude the Hong Kong population with a prevalence of mandibular canine impaction of 0.07% [15]. It is necessary to emphasize that mandibular canine impaction is less frequently the focus of research. In this regard, small differences in the prevalence of impacted mandibular canines among different populations are not significant, as they rarely exceed 1%.

Considering the number of impactions in the upper versus lower jaw, we can talk about a ratio of 17,714:1, with maxillary impaction occurring in over 94% of subjects of our sample. Similar to the results of other studies, which suggest roughly 20 times more frequent impaction in the maxilla compared to the mandible, the calculated ratio of our study fits into the initial assumption [12].

Maxillary canine impaction was more prevalent in females (2.21%) than in males (1.39%) in our study; however, this difference was not statistically significant, consistent with many other studies where gender differences rarely reach statistical significance. In contrast, a study conducted in Saudi Arabia in 2023 reported a higher prevalence among males compared to females [21], while research from the Dental College in North India in 2024 found a significantly higher prevalence in females than males [8].

Numerous studies have shown that canine impaction is more often unilateral than bilateral, and these results were in agreement with our study [8,21]. Most results from the literature report a frequency of unilateral impaction in 2/3 or more than 2/3 of subjects canine impactions. The reported ratio in our sample was 6,2:1 in favor of the unilateral impaction, so the difference was consequently statistically significant ($p\text{-value} < 0.0001$; $p < 0.05$).

In this research, there wasn't a big difference in the frequency of canine impaction on the right and left side of the jaw. In contrast to our results, there are similar surveys that show a higher prevalence on either side of the jaw [4,12,22].

The prevalence of impacted canines of 3.82% emphasizes the clinical significance of this irregularity in the population of Bosnia and Herzegovina, since it seeks proper and timely treatment in order to prevent potential complications. This study contributes to existing knowledge in dental research, as there is currently no data on the prevalence of impacted canines in Bosnia and Herzegovina. However, it should be noted that the current study has its limitations, especially regarding the sample size and its focus exclusively on patients who attended the Department of Orthodontics, University of Sarajevo – Faculty of Dentistry with Dental Clinical Center. In order to overcome these limitations, future research should include a bigger and more diverse sample of population in Bosnia and Herzegovina, to ensure greater accuracy.

Conclusion

- The prevalence of canine impaction was observed in 3.82% of subjects among orthodontic patients, and was more prevalent in female than in male subjects, but with no statistical significance.
- The already existing data which suggests more frequent unilateral impaction and impaction in the upper jaw, was again confirmed in this research.
- Knowledge of data on the prevalence of impacted canines is important for preventive and interceptive measures, for preventing complications and planning orthodontic treatment.

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Declaration of Interest:

The authors declare that they have no conflict of interest.

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