

Evaluation of the prevalence of impacted permanent second molars on panoramic radiographs

Gömülü daimi ikinci molar diş prevalansının panoramik radyograflarda değerlendirilmesi

Abstract

Aim: The objective of this study was to assess the prevalence of impaction in permanent second molars.

Methods: Panoramic images from 10.000 patients aged 15 and older, who presented to our clinic between January 2021 and January 2022, were meticulously examined. Inclusion criteria comprised 78 impacted second molars observed in 53 patients. The classification of second molars was conducted based on impaction type and angulation.

Results: The overall prevalence of second molar impaction was determined to be 0.53%, with 39.6% identified in female patients and 60.4% in male patients. Type 1 impaction was the most frequently detected and constituted 50%, while Type 2 and Type 3 impactions were detected at rates of 34.6% and 15.4%, respectively. Impaction types of mandibular second molar did not differ according to gender, side, or distance from the mandibular first molar distal surface to the anterior border of the ramus.

Conclusion: The prevalence of impacted permanent second molars was notably limited. Despite the infrequency of impaction, quick identification is critical for optimal treatment timing and the avoidance of associated consequences.

Keywords: Impacted tooth; molar; panoramic; prevalence

Öz

Amaç: Bu çalışmanın amacı daimi ikinci molar dişlerin gömülü kalma sıklığını değerlendirmektir.

Yöntemler: Ocak 2021 ile Ocak 2022 tarihleri arasında kliniğimize başvuran 15 yaş ve üzeri 10.000 hastanın panoramik görüntüleri değerlendirilmiştir. Çalışmada dâhil etme kriterlerini sağlayan, 53 hastada toplam 78 gömülü ikinci molar diş kullanılmıştır. İkinci molar dişlerinin sınıflandırılması gömülü tipine ve açılanmasına göre yapılmıştır.

Bulgular: İkinci molar diş gömülü olduğunun genel prevalansı %0,53 olarak saptanmıştır. Gömülü vakaların %39,6'sı kadın, %60,4'ü ise erkek hastalarda görülmüştür. En yaygın gömülü tip %50 oranında Tip 1 olarak belirlenmiştir. Tip 2 ve Tip 3 gömülü sıklıkları ise sırasıyla %34,6 ve %15,4 olarak tespit edilmiştir. Alt ikinci molar dişin gömülü kalma tiplerinin cinsiyet, taraf ya da mandibular birinci molar dişin distal yüzeyinden ramusun ön kenarına kadar olan mesafeye göre anlamlı bir farklılık göstermediği bulunmuştur.

Sonuç: Daimi ikinci molar dişlerin gömülü prevalansı oldukça nadirdir. Ancak sık gözlenmemesine rağmen, optimal tedavi zamanlaması ve ilişkili sonuçlardan kaçınmak için erken teşhis kritik öneme sahiptir.

Anahtar Sözcükler: Azı dişi; gömülü diş; panoramik; prevalans

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INTRODUCTION

The prevalence of tooth eruption failure or impaction, affecting nearly 20% of the population, underscores the importance of rigorous research to unravel the factors contributing to this common dental issue (1). The term “impacted” refers to the failure of tooth eruption due to either a physical obstruction in the eruption path or an abnormal tooth position (2). Although impacted teeth may exist in the jaws without manifesting symptoms or pathological formations, they can give rise to various conditions, including pericoronitis, trismus, infection, temporomandibular joint disorders, root resorption in adjacent areas, cystic formations, caries, and pain (3).

Third molars are the teeth most commonly affected by impaction, with maxillary canines and mandibular second premolars following in terms of frequency. The impaction of permanent teeth, excluding third molars, is a prevalent occurrence, with reported prevalence rates ranging from 0.01% to 2.3% (4-6). Canines and second premolars are the most frequently impacted teeth in both jaws, exhibiting varying incidence rates (7-9). Notably, permanent second molar teeth are seldom impacted and typically remain embedded in the mandibular arch. The reported incidence of impaction for second molars ranges between 0.06% and 3% in various studies (2,10-12). Nevertheless, in recent times, there has been a documented rise in reported incidence rates (11,12), a trend potentially ascribed to the heightened frequency of radiographic examinations.

According to Andreasen et al.(1), eruption abnormalities in permanent second molars stem from three primary causes. These include the presence of permanent second molars in ectopic positions, impediments obstructing their eruption path, and malfunction within the eruption mechanism. (1). The inability of tooth eruption may be linked to a spectrum of systemic and local factors, with heredity emerging as a recognized etiological contributor. Notably, recent investigations have identified familial instances of primary eruption failure (PFE) attributable to mutations in the parathyroid hormone receptor 1 (PTH1R) (13,14). Local factors encompass malocclusions evident in primary dentition, complications in the positioning of adjacent

teeth, spatial constraints within the dental arch, supernumerary teeth, idiopathic factors, and cysts (4,15).

The impaction of permanent mandibular second molars, while infrequently encountered in routine orthodontic and dental practice, proves to be more prevalent upon careful examination. The association of permanent mandibular second molars with various malocclusions, anomalies, adjacent teeth, and their respective foundations underscores the significance of meticulous treatment planning for prognostic considerations. The objective of this study is to ascertain the prevalence of impaction, delineate the types of angulation (horizontal, mesioangular, vertical, distoangular, other), and assess the impaction status (Type1, Type2, Type3) of permanent mandibular second molars.

MATERIALS AND METHODS

Ethics committee approval

Ethical clearance for the study was obtained from the Necmettin Erbakan University, Faculty of Dentistry, Local Ethics Committee (date: 23.02.2023, decision no: 2023/260). The research was conducted in strict adherence to the principles outlined in the Declaration of Helsinki. Informed consents were obtained from all patients, and all data were processed anonymously.

Data collection

The panoramic radiographs (PR) scrutinized in this investigation were randomly selected from individuals referred to the Oral and Maxillofacial Radiology Department at the Faculty of Dentistry, X University, spanning the period from January 2021 to January 2022.

Acquisition of the PRs was accomplished utilizing the Morita Veraviewepocs 2D panoramic unit (J Morita MFG Corp., Kyoto, Japan), with parameters set at 60-70 kVp, 5-7 mA, and exposure times of 6-8 s, aligning with the manufacturer's stipulations. Two experienced maxillofacial radiologists (AA and BÖ) meticulously assessed all data, conducted under optimal ambient lighting conditions, and viewed on an LCD monitor. The conclusive classification and radiographic interpretation of each observation were documented subsequent to attaining intra-observer consensus. Measurements were made by a single (BÖ)

observer. Inter-observer agreement was evaluated with the Cronbach's alpha test.

The outcomes of this retrospective investigation were derived through the assessment of panoramic radiographs and clinical records of patients seeking treatment at the Necmettin Erbakan University Faculty of Dentistry, Department of Dentomaxillofacial Radiology. A total of 10,000 pre-treatment panoramic radiographs from the department's archives were scrutinized. Inclusion criteria encompassed individuals aged 15 and above, whose mandibular second molar teeth had completed root development. Exclusion criteria involved individuals with congenital missing teeth, as well as those with hormonal or hereditary disorders. Additionally, individuals undergoing orthodontic treatment were excluded from the study, as such interventions could potentially alter the initial positions of second molars exhibiting eruption disorders, leading to a potential misdiagnosis. Those meeting the specified criteria were categorized based on the side of impaction (right or left, maxilla or mandible) and impaction status.

Regarding the type of impaction, five subgroups were delineated: mesioangular, distoangular, vertical, horizontal, and other (Figure 1). The acquired data were meticulously recorded using the Microsoft Excel program, and the distribution of the groups was analyzed as a percentage.

Statistical analysis

The frequencies of various risk factors, distinctions between the left and right sides, unilaterality or bilaterality, as well as different types of impaction, angulations of mandibular second molars (MSM), and the presence of cysts were evaluated. The relationships between the type of MSM impaction and other categorical variables, such as gender, impaction side, the number of patients with unilateral and bilateral eruption disturbances, mandibular second molar angulation, the presence of cysts, the presence of undercut, and risk factors, were assessed through chi-square tests. Disparities in continuous variables, such as the angle of molar inclination, impaction depth, and the distance from the distal surface of the mandibular first molar (MFM) to the anterior border of the ramus, among impaction types were evaluated using one-way

ANOVA. Distinctions between the mandibular right and left sides were examined using two-way ANOVA. The statistical analysis was performed using SPSS software (version 21.0; IBM SPSS Statistics, Armonk, NY, USA), with the threshold for statistical significance set at $p < .05$. The final classification and radiographic status of each tooth were meticulously documented following intra-observer consensus.

RESULTS

The repeatability of the measurements was determined to be at a Cronbach alpha value of 0.915.

A comprehensive evaluation involved 10,000 patients (mean age: 34.37 ± 12.45), comprising 5,812 women (mean age: 33.95 ± 12.46) and 4,188 men (mean age: 35.02 ± 12.4), ranging in age from 16 to 70. Within this cohort, an incidental occurrence of impacted permanent second molar was noted in 21 females (39.6%) aged between 16 and 52 years (mean age: 24.15 ± 7.23) and 32 males (60.4%) aged between 16 and 58 years (mean age: 21.61 ± 8.41).

The distribution of impacted permanent second molar teeth revealed 21 cases in the right maxilla, 17 in the left maxilla, 18 in the right mandible, and 22 in the left mandible. In the right maxilla, there are 9 occurrences of Type 1, 8 occurrences of Type 2, and 4 occurrences of Type 3. In the left maxilla, the distribution comprises 4 instances of Type 1, 7 instances of Type 2, and 6 instances of Type 3. Transitioning to the right mandible, there are 14 instances of Type 1, 3 instances of Type 2, and 1 instance of Type 3. In the left mandible, the distribution encompasses 12 instances of Type 1, 9 instances of Type 2, and 1 instance of Type 3 (Table 1). There is no statistically significant difference observed in impaction types with respect to gender ($p = 0.493$). Similarly, upon evaluating angulations based on gender, no statistically significant difference is discerned ($p = 0.771$). Among the panoramic radiographs of the 10,000 patients meeting the specified criteria, 53 individuals exhibited permanent second molar impaction, either unilaterally or bilaterally, amounting to a total of 78 impacted permanent second molar teeth.

The prevalence of permanent second molar tooth impaction among the studied population of 10,000 patients was determined to be 0.53%. Within the sub-

Table 1. Impaction types and angulations of the second molars

		Type 1	Type 2	Type 3	Type 1	Type 2	Type 3
Maxilla	Horizontal	-	-	-	-	-	-
	Mesiangular	2	1	3	1	1	2
	Vertikal	3	5	1	-	4	1
	Distoangular	4	2	-	3	2	2
	Other	-	-	-	-	-	1
Mandibula	Horizontal	-	-	-	-	1	-
	Mesiangular	7	1	1	5	4	-
	Vertikal	6	1	-	6	2	1
	Distoangular	1	1	-	1	2	-
	Other	-	-	-	-	-	-

Table 2. Demographic characteristics and baseline information of the patients categorized by impaction and retention status

	Primary retention	Secondary retention	Insufficient space	Ectopic eruption path	Cyst of jaw	Total
Number of Patients	10	32	8	-	3	53
Number of second molar	15	42	18	-	3	78
Number of unilateral or bilateral						
Unilateral	8	21	12		3	44
Bilateral	7	21	6		-	17
Gender						
Female	7	10	3		1	21
Male	8	14	8		2	32
Jaw						
Maxilla	9	21	7		1	38
Mandible	6	21	11		2	40

Table 3. Distance and depth measurements of mandibular second molar

	Right side				Left side			
	Type 1	Type 2	Type 3	p value	Type 1	Type 2	Type 3	p value
Distance of posterior space	1.74±0.66	1.56±0.17	1.79	0.896	1.5±0.54	1.57±0.21	1.84	0.748
Mesial depth of mandibular s. m.	0.22±0.16	0.65±0.05	1.83	0.000*	0.28±0.17	0.81±0.28	0.74	0.000*
Distal depth of mandibular s. m.	0.23±0.21	0.8±0.61	1.51	0.001*	0.22±0.16	0.58±0.26	0.68	0.003*
p value								0.762

s.m.: Second molar, *p<0.05 (statistically significant difference)

set of 78 impacted permanent second molars, 46 were unilaterally impacted (63.8%) (Figure 2), and 32 were bilaterally impacted (36.2%) (Figure 3). Notably, the permanent second molar tooth demonstrated impaction in all four quadrants in 6 patients.

Among the 78 teeth exhibiting eruption dysfunction, 15 were identified as having primary retention,

42 demonstrated secondary retention, and 18 were attributed to insufficient space. Notably, three teeth were found to exhibit eruption failure attributable to cysts (Table 2).

Upon comparing the distances of mandibular second molar teeth based on their impaction types, no disparity was identified in the posterior distance on



Figure 1. Data collection of maxillar and mandibular second molars

both the right and left sides ($p=0.896$, $p=0.748$). However, statistically significant differences according to impaction types were noted in both mesial and distal distances on both the right and left sides (Table 3). No significant difference was observed when comparing the right and left sides ($p = 0.762$).

DISCUSSION

Over the last two decades, cone-beam computed tomography (CBCT) three-dimensional (3D) imaging has become widely accessible in the dental profession. Its capability to furnish comprehensive information on various aspects and perspectives for assessing the 3D integrity of the buccolingual aspects of teeth, as well as cross-sectional cuts in multiple planes through individual teeth, underscores its utility in diagnostic imaging. The question may arise as to whether 3D images are more advantageous for research compared to panoramic radiographs (16). Nevertheless, the panoramic

radiograph remains a robust diagnostic tool, widely adopted as the initial step in the diagnostic process for most patients. It should be strategically employed to determine the necessity of CBCT for an individual patient before subjecting them to an elevated radiation dose, ensuring a judicious approach to imaging (12,17,18).

Numerous potential risk factors can be identified upon scrutinizing panoramic radiographs for eruption disorders associated with permanent second molars (PSM). Typically, the primary risk factor manifests as the major or initial obstacle impeding second molar eruption. Considering the sequential eruption of second molars from the apical to occlusal levels, factors impeding eruption at the apical or initial stages are deemed primary causative factors. Notably, the presence of mandibular third molars (MM3) can be erroneously perceived as the primary risk factor for PSM eruption disturbances (19-21). MM3 is often observed overlaying PSM in panoramic radiographs. However,



Figure 2. Unilateral impaction of MSM*, 18 years old male patient (*MSM: mandibular second molar)



Figure 3. Bilateral impaction of permanent second molars, 20 years old male

due to the earlier eruption timing of PSM compared to MM3, it becomes apparent that the primary risk factor for PSM eruption failure lies in factors other than MM3 resistance. This recognition underscores the importance of discernment in interpreting panoramic radiographs to ensure accurate identification of primary risk factors for eruption disturbances in PSM.

Impacted permanent second molars (PSM) are a very rare dental anomaly. Its prevalence reported in previous studies is highly variable (0.01% to 2.3%) (4,5). In this study, the incidence of impacted PSM was found to be 0.53%. Studies conducted in various societies show different prevalence values, indicating that this situation may be affected by the genetic and racial characteristics of the society. Müftüoğlu et al. (22) examined permanent mandibular second molars in 7352 patients who came to the orthodontic clinic and found a rate of 0.7% (56% female, 44% male). In this study, permanent mandibular second molars were detected in 30 patients (0.3%; 13 women, 17 men). Although

the same population was studied, the differences in findings may be due to the samples being obtained from different clinical departments. Casetta et al. (11), in their study examining 2945 orthodontic patients, found the prevalence of permanent mandibular second molars to be 1.36%. They detected it in a total of 40 patients, 23 of whom were male (57.5%) and 17 of whom were female (42.5%). The high rate of impaction of permanent mandibular number 7s may be due to the evaluation of patients coming to the orthodontic clinic. At the same time, it is important to use the radiology clinic archive, which includes all clinics instead of just a single clinic, in this study to provide more accurate prevalence results.

Upon assessing the prevalence of impacted teeth based on gender, the ratio of male to female patients was determined to be 1.52. In comparison to prior studies with varying reported rates, an examination was undertaken to ascertain any potential correlation between gender and disorders in permanent second molar tooth eruption. In alignment with our findings, Varpiro et al. (23) observed a higher incidence of eruption mechanism disorders and a greater prevalence of impacted mandibular second molar teeth in men. Conversely, Bacetti et al. (24) reported no discernible relationship between gender and the eruption disorders of permanent first and second molars. Consequently, a definitive conclusion regarding the correlation between gender and permanent second molar tooth eruption remains elusive.

Despite being infrequent, the identification of disturbances in second molar eruption is of substantial importance. The diagnostic process typically involves a comprehensive evaluation that combines clinical examinations and radiographic assessments. These distinct clinical and radiographic features usually facilitate differentiation between ectopic eruption, impaction, primary retention, and secondary retention (25-27). Moreover, the strategic alignment of treatment planning with the specific stage of eruption becomes not only a procedural necessity but also a critical directive. This strategic synchronization aims to initiate interventions precisely at the most opportune moment, consequently serving as a proactive measure in mitigating potential complications associated with the evolving dental condition.

An additional salient finding pertains to the discernible postponement in the eruption timeline of unaffected second molars among individuals manifesting either eruption disturbances or agenesis of the second molars (M2). The proposition posits that hereditary origins underlie anomalies in tooth positioning or the disruption of eruption paths (4,28). The existence of a genetic underpinning, coupled with the observed correlation between specific dental and developmental anomalies, implies that a cohort characterized by an elevated prevalence of one anomaly may exhibit a heightened occurrence of other associated anomalies, surpassing the prevalence observed within the general population.

Previous studies have posited a genetic correlation between dental anomalies impacting the maxillary lateral incisor and the mandibular second premolar (29-32). Notably, the existing body of research, while establishing this genetic link, has not specifically examined the severity of impaction in these dental conditions. The intricate nature of this genetic association prompts further investigation into the nuanced aspects of impaction severity, representing a notable gap in the current research landscape that warrants exploration for a more comprehensive understanding.

Limitations

It is essential to acknowledge that the study's inclusion source was not based on a census but rather on individuals voluntarily seeking radiographic examinations in our hospital, and this may be deemed a limitation. Another limitation is the evaluation of images within the selected date range. To minimize the potential influence and bias stemming from these limitations, a collaborative effort was undertaken, with two experienced clinicians conducting the scans through consensus.

CONCLUSIONS

Permanent second molar impaction is a relatively rare condition, with a prevalence of 0.53% in the Caucasian dental population. The prevalence of impacted permanent second molars was notably low, even lower than documented in prior reports. Despite the rarity of impaction, early diagnosis remains imperative for optimal treatment timing and the mitigation of potential complications.

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Conflict of interest and financial disclosure

The authors declare that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study.

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