Prevalence of Permanent Tooth Impaction and Associated Features in a Dental Population

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Abstract

Objectives: The aim of this study is to investigate the prevalence of permanent tooth impaction (excluding third molars) in a Jordanian dental population. A secondary aim is to study the distribution of impaction by side, arch and gender and its association with specific clinical features. **Methods**: A sample of 6,880 dental patients was surveyed for tooth impaction. The age limit ranged from 9 to 40 years. Impacted tooth, side, arch, gender, microdontia of maxillary lateral incisor, resorption of adjacent teeth, transmigration and retained deciduous teeth were recorded for each case diagnosed with impaction. Chi-square test, independent sample t-test, and Wilcoxon-Mann-Whitney U test were used for statistical analysis. **Results**: The prevalence of impaction was 6.7% (n=461) with no significant difference between males and females. Unilateral impaction (67.5%) was significantly more common than bilateral impaction (32.5%), but both sides were equally affected. Impaction in the maxilla (51.2%) was significantly more prevalent than that in the mandible (31.9%). The most commonly impacted tooth was the maxillary canine (50.3%) followed by the mandibular second premolar (36.2%), then the maxillary second premolar (18.4%), and finally, the mandibular canine (10.6%). Microdontia of the maxillary lateral incisor was significantly associated with impaction of the maxillary canine, while retained deciduous teeth associated with impaction were significantly more common in females than males. **Conclusions**: The prevalence and distribution of impaction were comparable with the findings from previous studies. This provides baseline epidemiological and demographic data for this selected population, which is important when planning referrals, interventions or dental treatments.

Keywords: Impaction, malocclusion, orthodontics, prevalence, pattern.

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Introduction

Eruption is a complex process where a tooth moves axially into its functional position in the oral cavity contributing to the normal development of the occlusion.[1] Disturbing this process might lead to failure of the eruption or impaction. Impaction of permanent teeth is a common dental anomaly. The diagnosis of an impacted tooth should follow clinical and radiographic assessment. If there was a physical barrier in the path of eruption or a positional deviation of the tooth follicle and the tooth is not expected to erupt, then this result in impaction.[1-3]

There are several local factors in the etiology of mild impaction of one or few teeth. These local factors may include dental crowding with narrow and\or short arches, an abnormal eruptive path, retained deciduous teeth, premature loss of deciduous teeth with thickened gingiva or loss of space for the successor, and the presence of supernumerary tooth, odontome or a pathology such as dentigerous cyst.[3,4] On the other hand, for

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patients with certain syndromes who present with multiple impacted teeth, the aetiology is more likely to be systematic.[4,5] The impaction of permanent teeth is a frequent phenomenon; if we excluded third molars then the reported prevalence would range from 2.9%[6] to 13.7%[7].[4,6-14] This considerable variation in the reported prevalence of impacted teeth could be attributed to the different populations, ethnic groups, selected age group, and diagnostic criteria that are reported on within the literature.[5-12,14,15]

A prolonged and complicated treatment may be required to align an impacted tooth to its normal functioning position in the oral cavity.[16,17] Therefore, epidemiological and demographic data reported on permanent tooth impaction is important for dental public health programs, screening for treatment priority, and resource planning.[18] Several studies were carried out to investigate the prevalence and distribution of impacted teeth in different populations,[4,6-15] but none was conducted in Jordan and most of these studies focused on a specific tooth type and did not comprehensively describe the pattern of impaction. Therefore, the aim of the present study was to:

1) Determine the prevalence of general and individual tooth impaction (excluding third molars) distributed by side, arch, number and gender in a sample of a Jordanian dental patients based on the relevant published literature.

2) Investigate the prevalence of a number of clinical features associated with impaction by gender, such as microdontia of the maxillary lateral incisor, resorption of adjacent teeth, transmigration, and retained deciduous teeth. Therefore, the null hypothesis of our study was that both genders, sides, jaws and all types of teeth are equally affected by impaction.

Materials and methods:

This was a cross-sectional observational study. Sample size was calculated based on an estimated prevalence of impaction of 9% (referring to previous studies)[4,6-11,13,14], confidence interval of 98% with a statistic corresponding of 2.33, and a precision of 0.01. The calculated sample size was 4,446 individuals.[19] Clinical records and digital panoramic radiographs for Jordanian dental patients aged 9 to 40 years, who attended Jordan University Hospital between 2015 and 2018, were analyzed. All digital panoramic radiographs were taken with the KODAK 8000 Digital Panoramic System® and viewed using the KODAK Dental Imaging Software®. The exclusion criteria included patients with incomplete clinical records, craniofacial syndromes and clefts, and previous history of extraction or orthodontic treatment. Following these criteria, 6,880 cases were included in this study (average age =16.3 years, males=44%, females=56%).

If a tooth was predicted to remain un erupted due to a physical barrier or a deflection along its eruption path or if it remained in the jaw two years after the expected eruption time, the tooth was rendered impacted.[3,7,20,21] The selected records were evaluated by an experienced researcher to determine the presence, type and number of permanent teeth (excluding third molars) diagnosed as impacted. In addition, the following variables were recorded for this investigation:

1) Number of impacted teeth.

2) Side affected: Bilateral or unilateral and if unilateral was it the left side or the right side.

3) Arch affected: Both arches or a single arch, and if a single arch was it the maxilla or the mandible.

4) Microdontia of maxillary lateral incisor (MicMx2): was diagnosed when mesio-distal width of the crown was less than that of the opposing mandibular lateral incisor.[22]

5) Resorption of neighboring roots.

6) Transmigration: an impacted tooth was defined as transmigrated when it crossed the midline regardless of the distance.[23,24]

7) Retained deciduous teeth: was diagnosed when the deciduous tooth was maintained in the arch with an impacted permanent successor.

The Statistical Package for Social Sciences (SPSS) version 25.0 (Armonk, NY: IBM Corp., 2017) was used for statistical analysis. Descriptive statistics and frequency tables were produced to describe the epidemiology of the impaction. The prevalence of impacted teeth and associated features were compared between genders using the chi-square test. On the other hand, Independent sample t-test was used to compare the number of impacted teeth between gender groups. The significance in distribution of the impacted teeth between sides and jaws was tested using z-test for proportions in the main sample and chi-square test between gender groups.[25] Wilcoxon-Mann-Whitney U test was conducted to determine the statistical significance of the ranked number of impacted teeth by gender followed by Post Hoc test. The level of significance for all tests was set at $P<0.05$.

Results:

Of the 6,880 surveyed records, 461 dental patients (males=45.1%, females=54.9%, mean age=16.3yr, SD= 7.5) had radiographic evidence of one or more impacted teeth. The prevalence of impaction was 6.7% with no significant difference between males (6.8%) and females (6.6%) ($X^2=0.25$, $P=0.62$).

The distribution of impacted teeth according to the affected side, arch, and number is shown in Table 1. The impacted teeth were more significantly prevalent on one side (unilateral=67.5%) than both sides (bilateral=32.5%) with $X^2=56.2$, $P<0.001$, but both sides were equally affected (left= 33.2%, right=34.3%) with $X^2=0.08$, $P=0.78$. In addition, impacted teeth were more significantly prevalent in a single arch)83.1%) rather than in both arches (16.9%) ($X^2=201.8$, $P<0.001$) and the maxilla (51.2%) was more significantly affected than the mandible (31.9%) ($X^2=20.7$, $P<0.001$). The side and arch pattern of impaction was compatible between males and females, except for the bilateral occurrence of the impaction, where males (39.4%) had significantly more bilateral impaction than females (26.9%) ($X^2=8.19$, $P=0.004$).

The total number of impacted teeth was 715, with an average of 1.6 impacted tooth per patient. Number of impacted teeth was significantly different between the gender groups (t=2.10, P=0.04, 95% confidence interval = 0.01 to 0.30). Nevertheless, the difference was not clinically significant, where on average each male had 1.6 impacted teeth while each female had 1.5 impacted teeth with a similar standard deviation of 0.8.

Following ranking of the number of the impacted teeth from one impacted tooth to five, more than 90% of the sample had one or two impacted teeth. While the rest of the sample had impaction ranging from 3 to 5 teeth. Males and females had comparable ranking of the number of the impacted teeth except for the second rank, where prevalence

of males with two impacted teeth (37.0%) was significantly higher than females (24.9%) (X^2=5.54, P=0.02). (Table 1)

The prevalence of impaction of each individual tooth in total, by arch and by gender is shown in table 2 and Figure 1. Prevalence of the impaction of each tooth was not significantly different between genders. The maxillary canine (50.3%) was the most commonly impacted tooth followed by the mandibular second premolar (36.2%), then the maxillary second premolar (18.4%), and the mandibular canine (10.6%).

Table 3 shows the associated features with impaction and its distribution by gender. The prevalence of microdontia of the maxillary lateral incisor was 10.6%. This feature was significantly associated with impaction of the maxillary canine (Kappa value=-0.099, P=0.001) but not with the other impacted teeth. Patients with microdontia of the maxillary lateral incisor had a prevalence of impacted maxillary canine of 73.5%, which was significantly higher than those without this dental anomaly (47.6%) (X^2=11.75, P=0.001). On the other hand, only 7 patients with impaction had root resorption of the surrounding teeth (1.5%); 6 out of the 7 had an impacted maxillary canine and only one had an impacted maxillary second premolar.

Transmigration was reported in 27 cases (5.9%) distributed as follows: transmigrated maxillary canine in 21 cases, transmigrated mandibular canine in 5 cases, and one case with transmigrated both maxillary and mandibular canines. Both gender groups had comparable prevalence of microdontia of maxillary lateral incisor, resorption of adjacent root(s), and transmigration. Nevertheless, the prevalence of retained deciduous teeth, that was found in 49% of our sample, was significantly higher in females (54.9%) than males (41.8%) (X^2=7.86, P=0.005). (Table 3) The tooth with the highest prevalence of retained deciduous teeth was the maxillary second premolar (70.6%), followed by the maxillary canine (55.6%), then the mandibular canine (51.0%), and finally the mandibular second premolar (43.1%).

Discussion:

In this study, the prevalence of impaction of permanent teeth (excluding third molars) in a large dental population was 6.7%, which falls within the range of 2.9%[6] to 13.7%[7] reported in other studies.[4,6-14] The wide range reported could be attributed to the different study designs, ethnicity of the included subjects, definition of the impaction, selection criteria and age limitations.

A very low prevalence of impaction of 0.49% was reported in a study that surveyed 27,592 Northern Indian dental patients.[26] This low percentage could be explained by the fact that there were no age limitations in the sample selection and the study did not exclude patients with a history of extraction or orthodontic treatment, which might have increased the false negative-findings and lowered the reported percentage.

Other figures representing the prevalence of tooth impaction that have been reported in other populations may include the Finnish dental patients (4.2%),[11] Ankara/Turkish orthodontic patients (2.9%),[6] United States army recruits (4.2%),[4] Colombian dental patients (3.1%),[14] New York/ United States dental patients (7.9%),[8] Antalya/Turkish orthodontic patients (9.1%),[10] Greek dental patients (13.7%)[7] and Chinese dental patients (5.6%)[13]. The three studies on Ankara orthodontic patients,[6] Antalya orthodontic

patients,[10] and Greek dental patients[7] reported the prevalence of impaction directly in their published study. Conversely, the percentages of impaction in the other studies were not reported and we had to retrieve the numbers and recalculate percentages, which was challenging. For this purpose we used data from the published tables to recalculate the prevalence of impaction by excluding the incidence of third molar impaction[4,8,11] or using the number of patients with impaction instead of the number of impacted teeth[13]. For example, the study on the Finnish dental patients, we had to exclude patients diagnosed with impaction of only third molars and we ended up with 170 cases from a total sample of 4,063 and the recalculated percentage was 4.2%.

The current study showed that unilateral impaction was significantly more prevalent than bilateral impaction and both sides were almost equally affected with no significant difference detected. In the literature, it was controversial as to which side was more affected by impaction. Fardi et al[7] reported no prominent side for the incidence of impaction after examining 1,239 panoramic radiograph of Greek dental patients. While both Topkara et al[10] and Aitasalo et al[11] found the left side to be more affected by impaction, but they didn't include tests for statistical significance. In addition, our study demonstrated significantly higher prevalence of impaction in a single arch rather than both arches and in the maxilla compared to the mandible (1.6:1), which is similar to the findings reported in the literature.[6,10,13] Topkara et al[10] studied 1,527 orthodontic patients and reported a ratio of the maxillary to mandibular impaction of 1.88:1. Similarly, Hou et al[13] studied 8,912 Chinese dental patients and found a ratio of 1.90:1.

The present data indicates no significant effect of gender on the prevalence of tooth impaction, which is in agreement with other studies.[6,7,10,11,14] Although Hou et al.[13] reported higher incidence of impaction in females, no statistical significant testing were performed. As shown in Fig 1, the most frequently impacted permanent tooth was the maxillary canine (50.3%) coinciding with the literature. The following three most frequently impacted teeth were the mandibular second premolar (36.2%), the maxillary second premolar (18.4%) and the mandibular canine (10.6%). This resembles results of previous studies,[7,10] although some would follow different order.[4,13] On the other hand, in a sample of 8,912 Chinese dental patients the maxillary incisor was third in incidence of tooth impaction. This could be attributed to the very young age groups that were included in the study, which would have increased the risk of false positive findings. In addition, the relatively increased mesio-distal width of the incisors relatively in the Chinese ethnicity[27] might have been a contributing factor for crowding and consequently impaction. Our study found no significant difference between males and females in the prevalence of the individual tooth impaction. Fardi et al[7] and Topkara et al[10] reported similar findings to our study, while Aitasalo et al[11] found that impacted maxillary canine was significantly more common in females than males, but this study only investigated the impaction of third molars and canines. Similarly, Dachi et al[15] found the impaction of maxillary canine to be significantly more common in females, nevertheless, the difference was not clinically significant.

Impacted teeth could be associated with a number of dental anomalies.[18] In our study, we

investigated four of these dental anomalies. Our results showed that microdontia of the maxillary lateral incisor was significantly associated with impacted maxillary canine. This was in accordance with previous studies.[28,29] In addition, only seven patients with impaction were diagnosed with resorption of the adjacent teeth. Similarly, transmigration affected only 5.9% of patients diagnosed with impaction and this was associated only with the impaction of canines. A lower prevalence of transmigration (4.2%) was reported by Fardi et al[7] and this was surprisingly associated with impacted premolars and molars. However, the exact definition of transmigration used in that study and the methodology used in the diagnosis was not explained in the published paper. Retained deciduous teeth was seen in 49.0% of our sample with the females affected more significantly than males. This was higher than the percentage reported by Fardi et al[7] (25.1%) and Hou et al[13] (25.0%) with no gender analysis provided.

Tooth impaction is a frequent phenomenon with considerable variation in its prevalence and distribution in different populations. An unerupted tooth is considered a clinical challenge in terms of diagnosis, chosen techniques, anchorage management and treatment duration.[3] Therefore, knowledge of epidemiology and pattern of impaction in a certain population is crucial for an earlier diagnosis and more efficient treatment of the impacted tooth with less complication and shorter treatment duration.

The current investigation has shed light on some areas in the study of impaction that were poorly reported on in previous research. However, several findings derived from the data in this study had limited generalizability since our sample was selected from a dental population that may not be a representative one. One more drawback in our study was the retrospective nature of the records analysis since we did not conduct any clinical examinations and had only access to pre-existing clinical records and radiographs.

Conclusions:

From our findings, the following conclusions were drawn:

1) The prevalence of impaction in the selected sample was 6.7%, which was comparable with other ethnic groups.

2) Prevalence of impaction was significantly unilateral rather than bilateral, affecting one arch rather than both arches, and occurring in the maxilla rather than the mandible.

3) The impaction of the maxillary canine was the most prevalent, followed by the mandibular second premolar, the maxillary second premolar and the mandibular canine.

4) Our study revealed equal distribution of permanent tooth impaction among males and females. Nevertheless, males had more significant bilateral impaction than females, while females had more significant prevalence of retained deciduous teeth associated with impaction than males.

5) Microdontia of the maxillary lateral incisor was significantly associated with impacted maxillary canine.

6) Transmigration affected solely the canines in both arches, but this occurred in the maxilla more often that the mandible.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

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Ethical approval: "All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: This study was retrospective, therefore, formal consent was not required."

Table1 Prevalence of patients with an impacted tooth according to affected side, arch, and number of impacted teeth distributed by gender. Number of patients with impacted teeth= 461 (males=208, female=253)

Pattern of impaction		Total (%)	Male N (%)	Female N (%)	Chi square value X^2	P-value
By side	Bilateral	150 (32.5)	82 (39.4)	68 (26.9)	8.19	0.004
	Unilateral:	311 (67.5)	126 (60.5)	185 (73.2)		
	• Left	153 (33.2)	60 (28.8)	93 (36.8)	0.21	0.65
	• Right	158 (34.3)	66 (31.7)	92 (36.4)		
By arch	Both arches	78 (16.9)	40 (19.2)	38 (15.1)	1.44	0.23
	Single arch:	383 (83.1)	168 (80.8)	215 (84.9)		
	• Maxilla	236 (51.2)	95 (45.7)	141 (55.7)	3.25	0.07
	• Mandible	147 (31.9)	73 (35.1)	74 (29.2)		
By number of impacted teeth	• One tooth	272 (59.0)	107 (51.4)	167 (65.2)	3.65	0.06
	• Two teeth	140 (30.4)	77 (37.0)	63 (24.9)	5.54	0.02
	• Three teeth	34 (7.4)	18 (8.7)	16 (6.3)	0.84	0.36
	• Four teeth	14 (3.0)	5 (2.4)	9 (3.6)	0.50	0.48
	• Five teeth	1 (0.2)	1 (0.5)	0 (0.0)	NA	NA

Table 2 Distribution of the prevalence of impaction for each individual tooth distributed by gender.

Impacted tooth in each arch		Prevalence within the sample presented with impaction (N=461, male=208, female=253)					Prevalence (%) within the surveyed sample (n=6,880)
		Total N (%)	Male N (%)	Female N (%)	Chi square value X^2	P-value	
Maxilla	Central incisor	12 (2.6)	6 (2.9)	6 (2.4)	0.12	0.73	0.17
	Lateral incisor	7 (1.5)	4 (1.9)	3 (1.2)	0.42	0.52	0.10
	Canine	232 (50.3)	102 (49.0)	130 (51.4)	0.25	0.62	3.37
	First premolar	22 (4.8)	11 (5.3)	11 (4.3)	0.22	0.64	0.32
	Second Premolar	85 (18.4)	37 (17.8)	48 (19.0)	0.11	0.74	1.24
	First molar	4 (0.9)	3 (1.4)	1 (0.4)	1.46	0.23	0.06
	Second molar	5 (1.1)	2 (1.0)	3 (1.2)	0.05	0.82	0.07
Mandible	Incisors	1 (0.2)	1 (0.5)	0 (0.0)	1.22	0.27	0.01
	Canine	49 (10.6)	24 (11.5)	25 (9.9)	0.33	0.57	0.71
	First premolar	18 (3.9)	9 (4.3)	9 (3.6)	0.11	0.67	0.26
	Second Premolar	167 (36.2)	85 (40.9)	82 (32.4)	3.53	0.06	2.43

	First molar	1 (0.2)	1 (0.5)	0 (0.0)	1.22	0.27	0.01
	Second molar	3 (0.7)	2 (1.0)	1 (0.4)	0.57	0.45	0.04

Table 3 Impaction and associated features distributed by gender.

Associated features	**Prevalence within the sample presented with impaction (N=461, males=208, females=253)**				
	Total N (%)	**Males N (%)**	**Females N (%)**	**Chi square value X^2**	**P-value**
Microdontia of the maxillary lateral incisor	49 (10.6)	20 (9.6)	29 (11.5)	0.41	0.52
Resorption	7 (1.5)	1 (0.5)	6 (2.4)	2.73	0.10
Transmigration	27 (5.9)	10 (4.8)	17 (6.7)	0.76	0.38
Retained deciduous teeth	**226 (49.0)**	**87 (41.8)**	**139 (54.9)**	**7.86**	**0.005**

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مدى انتشار طمور الأسنان الدائمة والميزات المرتبطة به في مجموعة من مراجعي قسم طب الأسنان

مريم محمد سالم العبد الله

قسم تقويم الأسنان، كلية طب الأسنان، الجامعة الأردنية.

الملخص

الأهداف: كان الهدف من هذه الدراسة هو التحقيق في انتشار طمور الأسنان الدائمة (باستثناء أضراس العقل) في مجتمع مرضى طب الأسنان الأردني. وكان الهدف الثانوي هو دراسة توزيع الطمور حسب الجانب المصاب والفك المصاب والجنس وارتباطه بسمات سريرية محددة. **الطريقة:** تم مسح عينة من 6880 مريض أسنان من أجل تشخيص طمور الأسنان. وتراوح الحد العمري من 9 إلى 40 عامًا. وتم تسجيل عدد ونوع الأسنان المطمورة، والجانب المصاب، الفك المصاب، والجنس، ووجود إصابة بصغر حجم القواطع الجانبية العلوية، وذوبان جذور الأسنان المجاورة، وترحال السن المطمور من خلال خط المنتصف، وبقاء الأسنان اللبنية دون تبديلها، تم استخدام اختبار Chi-square، واختبار t للعينة المستقلة، واختبار Wilcoxon-Mann-Whitney U للتحليل الإحصائي، **النتائج:** بلغ معدل انتشار الطمور 6.7٪ (العدد = 461) مع عدم وجود فرق بين الذكور والإناث، وكانت إصابة جانب واحد للفم (67.5٪) أكثر شيوعًا بشكل ملحوظ من إصابة الجانبين (32.5٪)، لكن كلا الجانبين (الأيمن والأيسر) تأثروا بشكل متساوٍ. وكان التأثير في الفك العلوي (51.2٪) أكثر انتشارًا من ذلك في الفك السفلي (31.9٪). وكان السن الأكثر تأثراً هو الناب العلوي (50.3٪) يليه الضاحك الثاني السفلي (36.2٪)، ثم الضاحك الثاني العلوي (18.4٪)، وأخيراً الناب الفك السفلي (10.6٪). ارتبط صغر حجم القواطع الجانبية العلوية بشكل كبير بطمور الأنياب العلوية، بينما كانت الأسنان اللبنية التي لم تتبدل والمرتبطة بالطمور أكثر شيوعًا في الإناث من الذكور. **الاستنتاجات:** كان انتشار طمور الأسنان وتوزيع التأثير قابلين للمقارنة مع نتائج الدراسات السابقة، ويوفر هذا البيانات الوبائية والديموغرافية الأساسية لهذه المجموعة السكانية المختارة، وهو أمر مهم عند التخطيط للإحالات أو التدخلات أو علاجات الأسنان.

الكلمات الدالة: الطمور، سوء الإطباق، تقويم الأسنان، الانتشار، النمط.