

# Prevalence and Gender Distribution of Permanent Tooth Agenesis among Jordanian Dental Patients: A Cross-Sectional Survey

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## Abstract

**Objective:** Tooth agenesis (hypodontia) is a common dental anomaly and an important aetiology of malocclusion. The aim of this study was to determine the pattern and distribution of hypodontia among a sample of Jordanian dental patients and to investigate the differences between genders, then compare the findings with those reported in the literature.

**Methods:** Orthopantomograms taken within a two-year interval were surveyed by three examiners to detect agenesis of permanent teeth (excluding third molars). Orthopantomograms of 8,225 patients (males=43%, females=57%) between the ages of 6 to 64 years were examined and descriptive data of hypodontia was analyzed and influence of gender on the distribution was investigated.

**Results:** The prevalence of hypodontia was 3.7% (n=302, males=3.3%, females=3.9%) with no significant difference between genders (P=0.17). Average number of missing teeth per patient was 1.9 (males=1.8, females=2.0) with the majority (85.4%) having one or two missing teeth and only 3.3% suffered oligodontia. Hypodontia was more common in the maxilla than the mandible (P<0.05) and on the left side in unilateral cases (P=0.036). The most frequent missing tooth was the maxillary lateral incisor (2.05%) followed by the mandibular second premolar (1.22%).

**Conclusions:** The prevalence of hypodontia among Jordanian dental patients was compatible with those reported for other ethnic groups with some differences found in the analyzed patterns. There was no influence of gender on the distribution of hypodontia, which suggest weak evidence for the X-linked inheritance for this anomaly.

**Keywords:** Hypodontia, Oligodontia, Epidemiology, Malocclusion, Orthodontics, Anomalies, Gender role.

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## Introduction

Tooth agenesis, also known as hypodontia, is one of the most commonly prevalent dental anomalies in any population.<sup>(1,2)</sup> This anomaly

can be classified as syndromic or non-syndromic. Most common syndromes associated with tooth agenesis are ectodermal dysplasia, Down syndrome and Cleft lip and palate.<sup>(3)</sup> Another classification of dental

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agenesis based on the number of missing teeth, excluding third molars, divides cases into: hypodontia (up to 5 teeth are missing), oligodontia (6 or more teeth are missing), and anodontia (all teeth are missing).<sup>(4,5)</sup> The aetiology for hypodontia is believed to include both environmental and inherited factors. Environmental factors may include radiotherapy, chemotherapy, trauma, infection, or nerve disturbances.<sup>(1,6,7)</sup> On the other hand, a number of genes coding for MSX1, PAX9 and AXIN2 factors were identified in patients with tooth agenesis supporting the link of inheritance to this anomaly. In addition, the association between hypodontia and other dental anomalies like peg-shaped laterals, transposition, impaction, or abnormalities in size and shape of teeth may further reinforce this genetic theory.<sup>(3,8)</sup>

The prevalence of hypodontia in different populations was studied extensively reporting a wide range of results varying from 2.7% in Mexico<sup>(9)</sup> to 12.2% in Germany<sup>(10)</sup>. Such variation could be elucidated by differences in sampling methods, racial origins, exclusion criteria, age limitations, gender distribution and era of the research. Similarly, the most frequent missing teeth reported in these studies were the lower second premolars, the upper lateral incisors, the upper second premolars, and the lower incisors competing on the first, second, third, and fourth places based on sample origin and study design.<sup>(4,9-21)</sup>

In dentistry, missing teeth is a challenging feature of malocclusion that requires careful diagnosis, space analysis and treatment decision to open or close spaces. Early diagnosis of tooth agenesis may provide an interceptive window to apply suitable measures to eliminate need for future expensive treatment, lessen the severity of the

developing malocclusion, and reduce the time required for the definitive treatment.

Patterns and distribution of hypodontia in Jordanian dental patients was never investigated. Therefore, the aim of this study was to conduct a cross-sectional survey to determine the prevalence and gender distribution of hypodontia in a sample of Jordanian dental and to compare the results with other studies.

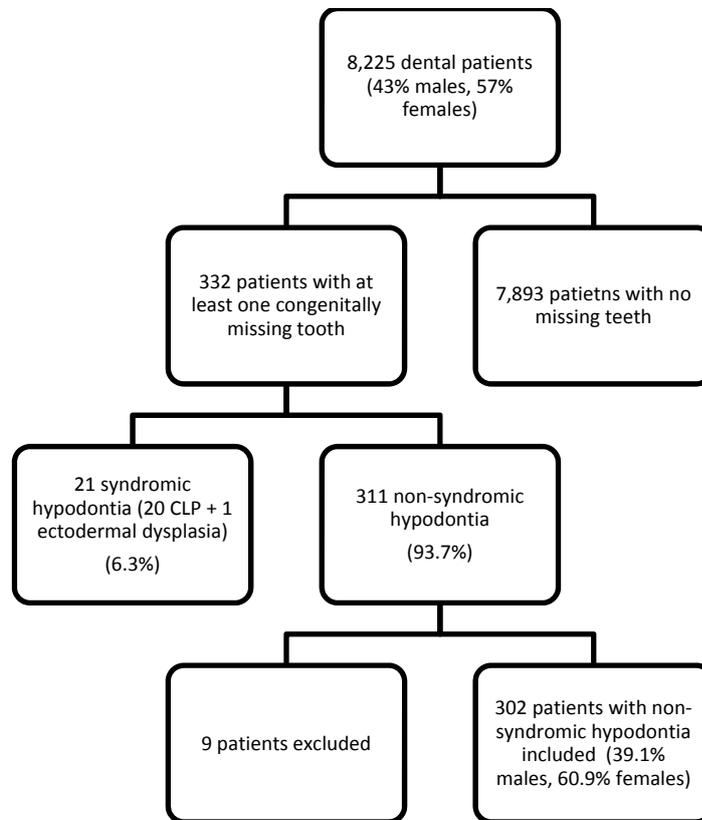
### **Materials and Methods**

The protocol of the study was approved by the Research Ethics Committees of the Jordan University Hospital and the Faculty of Dentistry, The University of Jordan. Jordan University Hospital is positioned at the centre of Amman, the capital of Jordan, and it provides medical and dental services not only for people living in the capital city but also for many others living in the surrounding provinces. Yearly, an average of 700,000 patients attends the hospital, 6% of which seek dental consultation and treatment. All digital orthopantomograms of patients who attended any of the dental specialty clinics at the Jordan University Hospital from the 1<sup>st</sup> of October 2011 till the 1<sup>st</sup> of October 2013 were included in the study.

The use of orthopantomograms to diagnose abnormalities in tooth number proved to be a reliable tool that has been used in previous studies.<sup>(5,13,22)</sup> All orthopantomograms were taken using a KODAK 8000 Digital Panoramic System<sup>®</sup> and viewed using the KODAK Dental Imaging Software<sup>®</sup>. A total of 8,225 orthopantomograms (43% males, 57% females) were surveyed by three examiners; an orthodontist (M.A.), a radiologist (A.A.) and a general dental practitioner (R.S.). The age of participants ranged from 6 to 64 years with an

average of 27.4 years (SD=12.1 years). All permanent teeth were included in the study except for third molars. A tooth was considered congenitally missing when there

was no sign of calcification of the crown on the radiograph and no evidence or history of tooth loss as a result of periodontal disease, trauma, caries, or orthodontic treatment.



**Figure 1. Flow chart showing the number of patients through the process of sample selection in the current study. CLP: cleft lip and palate**

Microsoft Excel (Microsoft office 2007)<sup>®</sup> was used for data entry. Data included file number, patient's name, gender, date of birth, date of taking the orthopantograms, number and type of missing teeth, missing side, and affected arch. The excel sheet was then transferred to SPSS program version 19.0 (Chicago, Illinois, USA, 2010)<sup>®</sup> for statistical analysis. Descriptive analysis and frequency tables were used for general description of the results then chi-square test was performed to identify any significant differences in the prevalence and pattern of hypodontia between

genders. Significant difference for the proportions of binary data and non-binary categorical data was tested using z-test for proportions and chi-square test, respectively. For numerical values (age and number of missing teeth) independent sample t-test was used. The level of significance was set at  $P < 0.05$ .

### Results

At least one missing permanent tooth was identified in 332 patients. Patients diagnosed with cleft palate ( $n=20$ ) and ectodermal

dysplasia (n=1) were excluded. Out of the 311 cases diagnosed with non-syndromic hypodontia nine cases were excluded due to incomplete records resulting in 302 cases. (Figure 1).

Prevalence of hypodontia was 3.7% with a gender distribution of 39.1% (n=118) males and 60.9% (n=184) females. Prevalence of hypodontia in males was 3.3% and for females 3.9% with no significant difference (P=0.17). The age of the patients ranged between 6.3 and 55.6 years with an average of 21.4 years and a standard deviation (SD) of 9.7 years. Average age for males was 20.0 years (range= 6.7-54.2 years, SD= 9.4 years) and for females 22.2 years (range= 6.3-55.6 years, SD= 9.8 years) with no significant difference found (P=0.13).

To ensure the absence of bias due to the age factor, patients (n=302) were categorized using two different methods. Firstly, and since the literature is suggesting a risk of false positive findings when patients are aged below 10 years as a result of delay calcification of the lower second premolars<sup>13,23</sup>, our sample was categorized into two groups: those who aged below 10 years (n=33) and those who were 10 years or above (n=269). Then both groups were compared using chi-square test for the prevalence of congenitally missing lower second premolar. Patients aged below 10 years had a prevalence of congenitally missing lower second premolars of 45.5% (15/33) and those aged 10 years or above had 31.6% (85/269) with no significant difference found (P= 0.11).

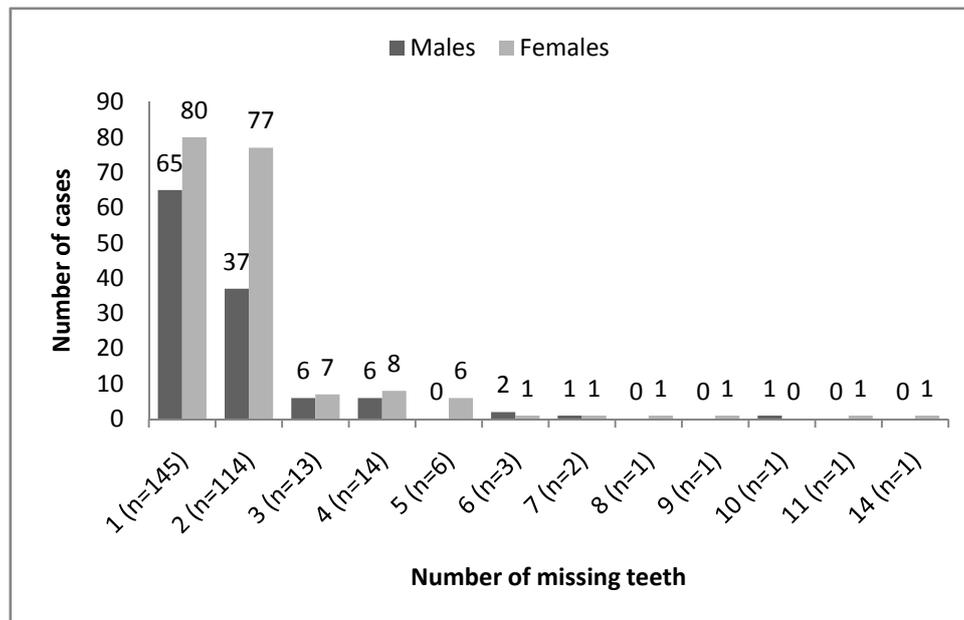


Figure 2. Distribution of the number of missing teeth between males and females

Secondly, and since the majority of previous studies investigating the prevalence of tooth agenesis restricted the age of the included subjects to those younger than 20 years<sup>(9,13-15,17,18)</sup>, our sample was divided into two groups: patients aged below 20 years

(n=139) and patients aged 20 years or above (n=163). Then numbers of missing teeth were compared using independent sample t-test. The average number of missing teeth for patients aged below 20 years was 2.1 (SD=1.9) and for those aged 20 years or above was 1.8 (SD=1.2)

with no significant differences found between both age groups ( $P=0.054$ ). Therefore, all age groups were included in the study with no bias being introduced to the results.

The total number of missing teeth, excluding third molars, was 584 teeth with an average of 1.9 teeth per patient (min: 1, max:14). Males had 210 missing teeth with an average of 1.8 teeth per case while females had 374 missing teeth with an average of 2.0 teeth

per case with no statistically significant difference found between genders ( $P=0.19$ ). Hypodontia of one or two teeth was found in the majority of cases (85.4%,  $n=259$ ), while hypodontia of 3 to 5 teeth was found in 11.5% of the cases ( $n=33$ ); and only 3.3% had oligodontia ( $n=10$ ). Figure 2 shows the distribution of the number of missing teeth between genders.

**Table 1. Pattern and prevalence of hypodontia between genders**

Total sample = 8,225 (males=3,537, female=4,688). Total number of subjects with congenitally missing teeth= 302 (males=118, female=184)									
Pattern of hypodontia	Males			Females			Total		
	n	% in the main sample <sup>1</sup>	% in the hypodontia group <sup>2</sup>	n	% in the main sample <sup>3</sup>	% in the hypodontia group <sup>4</sup>	n	% in the main sample <sup>5</sup>	% in the hypodontia group <sup>6</sup>
Bilateral	53	1.5	44.9	94	2.0	51.1	147	1.8	48.7
Unilateral:	65	1.8	55.1	90	1.9	48.9	155	1.9	51.3
• Left	40	1.1	33.9	51	1.1	27.7	91	1.1	30.1
• Right	25	0.7	21.2	39	0.8	21.2	64	0.8	21.0
Both arches	17	0.5	14.4	34	0.7	18.5	51	0.6	16.9
Single arch:	101	2.9	85.6	150	3.2	81.5	251	3.1	83.1
• Maxilla	59	1.7	50.0	97	2.1	52.7	156	1.9	51.6
• Mandible	42	1.2	35.6	53	1.1	28.8	95	1.2	31.5

<sup>1</sup> Percentage of males affected relative to the males in the main sample.

<sup>2</sup> Percentage of males affected relative to the males in the hypodontia group.

<sup>3</sup> Percentage of females affected relative to the females in the main sample.

<sup>4</sup> Percentage of females affected relative to the females in the hypodontia group.

<sup>5</sup> Percentage of subjects affected relative to the main sample.

<sup>6</sup> Percentage of subjects affected relative to the hypodontia group.

General pattern of the location of tooth agenesis for both genders is presented in Table 1. Bilateral missing teeth occurred in 48.7% of the cases and was not significantly different from the unilateral prevalence of 51.3%. Nevertheless, the unilateral missing teeth occurred significantly more on the left side (58.7%) than the right side (41.3%) with a P-

value of 0.036. Prevalence of missing teeth in a single jaw was significantly more common than affecting both jaws ( $P<0.05$ ) with a ratio of 5:1. Similarly, the upper jaw was significantly more affected by tooth agenesis than the lower jaw ( $P<0.05$ ) with a ratio of 1.6:1. There was no statistically significant difference in the pattern of hypodontia

between genders.

Distribution of hypodontia for each individual tooth classified by the affected arch and side are shown in Table 2. The most commonly missing tooth was the upper lateral incisor with a prevalence of 2.05% followed

by the lower second premolar (1.22%), then the upper second premolar (0.53%) followed closely by the lower incisors with a prevalence of 0.52%. No statistically significant difference was found based on gender.

**Table 2. Distribution of hypodontia for each individual tooth**

Distribution of hypodontia (Total number of missing teeth =584)		Left side	Right side	Bilateral	Total (%)
Maxilla	Central incisor	1	1	0	2 (0.3)
	Lateral incisor	47	42	80	249 (42.6)
	Canine	3	3	4	14 (2.4)
	First premolar	5	4	3	15 (2.6)
	Second Premolar	15	8	21	65 (11.1)
	First molar	0	0	0	0 (0)
	Second molar	0	0	1	2 (0.3)
Mandible	Incisors	15	10	18	61 (10.4)
	Canine	2	1	2	7 (1.2)
	First premolar	6	4	1	12 (2.1)
	Second Premolar	32	13	55	155 (26.5)
	First molar	0	0	0	0 (0)
	Second molar	0	0	1	2 (0.3)

**Discussion:**

Jordan University Hospital (JUH) serves a large number of patients who live inside and outside the capital city, Amman. The sample of this study was patients who attended the hospital seeking dental consultation or treatment. Therefore, the sample was deemed a good representative of the general Jordanian population. Within a two-year interval, 8,225 dental patients whom carried out orthopantograms in the hospital (43% males, 57% females) were investigated in this study. The number of patients diagnosed with hypodontia and included in the study was 302 (39.1% males and 60.9% females).

The prevalence of hypodontia (excluding third molars) calculated in our study was 3.7% (females= 3.9%, males= 3.3%). Our result would fit in the lower range of the reported prevalence of hypodontia between 2.7% and 12.2%.<sup>(4,9-21)</sup> (Table 3) This could be partially explained by the fact that our study targeted general dental patients while the sample used in several previous studies was orthodontic patients. Since dental treatment for the majority of patients diagnosed with tooth agenesis requires orthodontic intervention, it is expected that a sample derived from orthodontic patients would have a higher

prevalence of hypodontia than those of dental patients or the general population.

In addition to sampling methods, ethnical and genetic background of the studied population may contribute to the differences in the published prevalence of hypodontia as shown in Table 3. The present study showed

no significant difference in the prevalence of hypodontia between males (3.3%) and females (3.9%) (P=0.170). These findings coincide with the previous studies except for the Meta analysis by Polder et al. where females were significantly more affected than males<sup>4</sup>.

**Table 3. Summary of hypodontia studies on different populations.**  
(U: upper, L: lower, 2: lateral incisor, 5: second premolar)

Author (Year)	Country	Sample size	Sample (age)	Prevalence %	Most frequently missing teeth
O'Dowling and McNamara (1990)	Ireland	3,056	Orthodontic patients (7-17yr)	11.3	L5
Thongudomporn and Freer (1998)	Australia	111	Orthodontic patients (10-26y)	8.1	L5
Silva Meza (2003)	Mexico	668	Orthodontic patients (9-20yr)	2.7	U2 L5
Endo (2006)	Japan	3,358	Orthodontic patients (5-15yr)	8.5	L5 L2 & U2
Altug-Atac and Erdem (2007)	Turkey	3,043	Orthodontic patients (8.5-15yr)	2.8 <sup>1</sup>	U2 U5 & L5
Harris and Clark (2008)	USA	Black : 600 White : 1,100	Orthodontic patients (12-18yr)	Black: 4.8 White: 6.2	U2 L5
Chung et al. (2008)	South Korea	1,622	Orthodontic patients	11.2	L2 & L5
Rolling and Poulsen (2009)	Denmark	8,138 <sup>2</sup>	School children (9-12yr)	7.1	L5 U5 & U2
Gomes et al (2010)	Brazil	1049	Orthodontic patients (10-16yr)	6.3	U2 L5
Vahid-Dastjerdi et al (2010)	Iran	1,751	Orthodontic patients (9-27yr)	9.1	U2 U5
Behr et al. (2011)	Germany	1,353	Orthodontic patients (5-44yr)	12.2 <sup>3</sup>	L5 U2

1. Prevalence of hypodontia includes the reported prevalence of oligodontia.
2. Samples of two researches were combined (1974-1979:n=3325, 1992-2002:n=4813)
3. Syndromic hypodontia cases excluded.

The majority of the research conducted to test the prevalence of hypodontia limited the age of the selected sample to children,

adolescents and young adults.<sup>(9,13-15,17,18,21)</sup> This could be due to the contribution of complicated factors affecting the aetiology of

missing teeth in adults where periodontal diseases, trauma and caries start to play a role; and careful assessment of the dental history is essential. Moreover, dental records for children and adolescents are more reliable and satisfactory in paediatric and orthodontic departments when studying hypodontia. In the current study and to ensure validity of the results, our patients were categorized and further statistical analyses were carried out as described in the result section. Our results confirmed that patients aged below 10 years had similar prevalence of lower second premolars agenesis compared with the older group ( $P=0.11$ ). In addition, patients aged below 20 years had no significant difference in the number of missing teeth compared to the older group ( $P=0.054$ ). Moreover, including participants aged younger than 10 years or older than 20 years was not uncommon in hypodontia studies. In Behr et al. study<sup>(10)</sup> the age of participants ranged from 5 to 44 years and in Albashaireh and Khader study<sup>(20)</sup> it ranged from 16 to 45 years. Furthermore, genetic turn over and mutations that might change the prevalence of hypodontia requires a long time to be expressed within a population. The age-range of our sample covered almost six decades, and this is not long enough to show significant modifications to the prevalence or the pattern of hypodontia between generations.<sup>(16,18)</sup>

Mild hypodontia with agenesis of one or two teeth accounted for the majority of cases (85.4%) in the present study. This is consistent with the findings of other studies reporting this range between 67.8% and 89.9%.<sup>(12-14,18)</sup> Similarly, the most frequently missing tooth in our study was the upper lateral incisor (2.05%) followed by the lower second premolar (1.22%). This pattern was in agreement with some studies<sup>(9,14,15)</sup> on one hand and disagreed

other studies<sup>(10,16,20)</sup> that reported the lower second premolar followed by the upper lateral incisor as the most frequently missing teeth. A study showed that the Korean population showed different patterns of tooth agenesis where the lower lateral incisors were the most commonly affected.<sup>12</sup> Irrespective to differences in sampling methods and ethnic variation, missing teeth in mild hypodontia are almost always those most distal in any given tooth type.<sup>(1,2,5)</sup>

The present study reported equal frequency of bilateral and unilateral tooth agenesis with a ratio of 1:1. This is in contrast with some studies that reported bilateral hypodontia to be significantly higher than a unilateral hypodontia.<sup>(9,11,13)</sup> On the other hand Chung et al. found that unilateral frequency of hypodontia was significantly higher than bilateral with a ratio of 2.3:1.<sup>(12)</sup> When unilateral hypodontia was investigated, our study showed the left side to be more significantly affected than the right side ( $P=0.036$ ). Reporting the most affected side in unilateral hypodontia was not consistent in the literature and was not always stated in the published text but presented in tables and figures and had to be calculated and concluded. Behr et al. study<sup>(10)</sup> agreed with our findings where the left side was dominant, whereas, the Silva Meza study<sup>(9)</sup> found both sides to be equally affected, and other studies reported the right side to be dominant with no significant differences calculated in any of the studies.<sup>(12,14)</sup>

Previous research reporting the prevalence of hypodontia in the maxilla to be higher than the mandible is in agreement with the findings of our study.<sup>(9,11,14,19)</sup> This finding is also compatible with the location of the teeth reported as the most frequently missing in these studies including the present one which

is the upper lateral incisors. Other studies found the prevalence of hypodontia in the mandible to be higher than the maxilla with the lower lateral incisors and the lower second premolars reported as the most frequently missing teeth.<sup>(10,12,13,18)</sup> None of these studies carried out statistical significant testing of the prevalence of hypodontia between the maxilla and the mandible except for Chung et al.<sup>(12)</sup> where the mandible was more significantly affected than the maxilla and Goya et al.<sup>(24)</sup> with the mandible more affected but not to a significant level.

Studying the prevalence of a certain health problem in a population carries many benefits. This piece of information can lead to the development of clinical guidelines to direct future research and public funds to target those problems efficiently. These guidelines and recommendations may include early screening of the health problems, preventive and interceptive measures, parents' and clinicians' education, and development and improvements in patient management. The results of this study provide the basic information for clinicians on the pattern and gender distribution of tooth agenesis among Jordanian dental patients. Nevertheless, further studies are necessary to relate hypodontia to other dental anomalies and malocclusions to provide

the necessary information to establish a comprehensive interdisciplinary treatment planning and management for hypodontia patients.

### **Conclusion**

The prevalence of hypodontia in a sample of Jordanian dental patients was 3.7% with no significant difference based on gender ( $P=0.17$ ). The most frequently missing tooth was the maxillary lateral incisor followed by the mandibular second premolar. The maxilla was more affected than the mandible ( $P<0.05$ ) and the left side more than the right side ( $P=0.036$ ). Mild hypodontia of one or two missing teeth was predominant among Jordanians (85.4%).

Findings of the present study showed similarities and differences with previous published literature with no influence of gender on the pattern and frequency of tooth agenesis.

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## مدى انتشار فقد الأسنان الوراثي وتوزيع النسب بين الجنسين لمجموعة من مرضى الأسنان الأردنيين: دراسة مسحية مستعرضة

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### الملخص

**الهدف:** يُعد فقد الأسنان الوراثي تشوهاً يصيب الأسنان، وهو الأكثر شيوعاً من بين حالات تشوه الأسنان، ويعد من المسببات المرضية المهمة لسوء الإطباق. وقد كان الهدف من هذه الدراسة هو تحديد نمط وتوزيع فقد الأسنان الوراثي لدى عينة من مرضى الأسنان الأردنيين والتحقيق في اختلافات هذا النمط بين الجنسين، ثم مقارنة النتائج مع تلك التي ذكرت في الدراسات السابقة.

**الطريقة:** صور أشعة البانوراما المأخوذة ضمن فترة زمنية مقدارها عامين تم فحصها من قبل ثلاثة باحثين للكشف عن عدم تخلق الأسنان الدائمة (باستثناء الأضراس الثالثة). تم فحص عدد من صور الأشعة مقداره 8,225 صورة (الذكور = 43٪، الإناث = 57٪) وكانت تتراوح أعمارهم ما بين 6 و64 عاماً وتم تحليل البيانات الوصفية للفقد الوراثي للأسنان وتم التحقيق في تأثير الجنس على التوزيع.

**النتائج:** كان انتشار فقد الأسنان الوراثي هو 3.7٪ (حجم العينة = 302، ذكور = 3.3٪، الإناث = 3.9٪) مع عدم وجود فرق كبير بين الجنسين ( $P = 0.17$ ). وبلغ معدل عدد الأسنان المفقودة لكل مريض 1.9 (ذكور = 1.8، الإناث = 2.0) مع كون الأغلبية (85.4٪) تعاني من وجود واحد أو اثنين من الأسنان المفقودة و3.3٪ من العينة يعانون من وجود ستة أسنان مفقودة أو أكثر. كانت الأسنان المفقودة وراثياً منتشرة في الفك العلوي أكثر من الفك السفلي ( $P > 0.05$ ) وعلى الجانب الأيسر في حالات أحادية الجانب ( $P = 0.036$ ) أكثر من الجانب الأيمن. وكانت الأسنان المفقودة والأكثر شيوعاً هي الرباعيات العلوية (2.05٪) تليها الضاحك الثاني السفلي (1.22٪).

**الاستنتاجات:** كان انتشار فقد الأسنان الوراثي بين مرضى الأسنان الأردنيين متوافقة مع تلك التي أبلغت للجماعات العرقية الأخرى مع بعض الاختلافات التي وجدت في أنماط تحليلها. لم يكن هناك أي تأثير لنوع جنس المريض على توزيع فقد الأسنان الوراثي، مما تشير إلى وجود أدلة ضعيفة الميراث المرتبطة بجين X لهذه الحالة.

**الكلمات الدالة:** فقد الأسنان الوراثي، نقص الأسنان، وعلم الأوبئة، سوء الإطباق، تقويم الأسنان، تشوه الأسنان، دور الجنس.