ORIGINAL ARTICLE

Tooth Agenesis Code (TAC) Analysis of Non-syndromic Hypodontia

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ABSTRACT

Introduction: Hypodontia is one of the common dental anomalies influenced by several factors in dental development such as genetic and environmental factors. This study aims to estimate the prevalence and pattern of non-syndromic hypodontia excluding third molars among orthodontic patients at the orthodontic clinic. **Methods:** A total of 630 patients (n = 630) (459 females, 171 males) attending orthodontic clinic from 2011 to 2019 were assessed. Dental records; panoramic radiographs, and study casts were used to identify patients with missing permanent teeth, excluding third molars. TAC Data Analysis Tool method was used to determine the prevalence and pattern of non-syndromic hypodontia excluding third molars. **Results:** 84 missing teeth excluding third molars were found from a total of 45 patients with a range age from 7 to 34 years old when the pre-treatment OPGs were taken. The average number of missing teeth per patient is 0.13+0.61. The prevalence of non-syndromic hypodontia excluding third molars among orthodontic patients is 7.1%, where the incidence is higher in the mandible than in the maxilla. The most common missing teeth are the maxillary lateral incisors (27.5%), followed by mandibular lateral incisors (24.0%), and maxillary second premolars (12.0%). A bilateral tooth missing (53.6%) was more common than unilaterally missing teeth (46.4%). No first molar teeth and maxillary central incisors were reported missing. **Conclusion:** This study shows that 7.1% of orthodontic patients at orthodontic clinic have non-syndromic hypodontia. These phenotypic findings further confirm the need to ascertain the genotypic study of non-syndromic hypodontia.

Keywords: Hypodontia, Orthodontics, Prevalence

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INTRODUCTION

Developmental dental anomalies are common findings influenced by several factors in dental development such as genetic and environmental factors (1). This would result in various dental morphologies that differ in size, shape, and structure (2). It encompasses an anomaly in the number of teeth where there is a complete absence of a tooth germ, as well as variations in the position of the teeth in the arch (3).

Al-Jabaa AH et al. (2013) (4) stated that rates of anomalies in orthodontic patients are higher than the general population, which affects the diagnosis and planning of orthodontic treatment. Functional, occlusal, and aesthetic problems usually arise when dental anomalies occur (5). Aesthetic, functional, emotional, and physical problems are usually affected by congenitally missing teeth, especially during adolescence (6).

Hypodontia can be defined as the congenital absence of teeth. The prevalence of hypodontia excluding third molars ranges from 1.0% to 7.2% in various populations (2,7–10). On the other hand, Endo et al. (2006) (11) and Fekonja A (2015) reported that the prevalence of hypodontia among orthodontic patients was between 2.7% to 11.3%. The prevalence of non-syndromic hypodontia excluding third molars among children in Romania was 2.8% (12).

In Malaysia, research by Mani SA et al. (2014) (13) on Malay children found that an average of 2.3 teeth was missing per child. 25.7% of the children have missing third molars. From the study, maxillary lateral incisors were found to be the next common missing tooth with a percentage of 1.7%, followed by maxillary and mandibular second premolars. From a clinical cohort study done in International Islamic University Malaysia (IIUM), the prevalence of non-syndromic hypodontia excluding third molars for IIUM Dental Polyclinic patients was 1.0% (7).

Studies on patterns of hypodontia are mostly limited to the clinical cohort and paediatric population in

Malaysia (7,13). From clinical experience, more cases of hypodontia were found among the orthodontic patients at orthodontic clinic and most of the cases presented with missing maxillary/mandibular second premolars but there is no scientific evidence yet to support the findings. It is postulated that orthodontic patients exhibit more unique patterns of hypodontia compared to Malaysian normal populations and orthodontic patients in other countries. Therefore, this research aimed to estimate the prevalence and pattern of non-syndromic hypodontia among orthodontic patients by using the TAC Data Analysis Tool method.

MATERIALS AND METHODS

Ethics
Ethical approval was obtained from The Human Research Ethic Committee of Universiti Sains Malaysia (USM/JEPeM/19030189).

Population sample
A total of 952 patients attending orthodontic specialist clinic from 2011-2019 were screened and 322 patients had to be excluded due to incomplete records (missing radiographs or study casts). The identification of all orthodontic cases was retrieved from the digital health record information system in Orthodontic Clinic, known as the CARE2X.

Inclusion and exclusion criteria

Inclusion criteria
Patients with at least one and more congenitally missing permanent teeth excluding third molars.

Exclusion criteria
Free from any associated syndromes such as Down syndrome, cleft lip and palate, ectodermal dysplasia, and other syndromes related to hypodontia. Histories of tooth loss due to trauma, caries, periodontal disease, orthodontic extraction, or any orthognathic surgery. Incomplete or/and poor quality of dental records. The diagnosis of previous extractions and any history of surgeries done on patients was made based on the data retrieved from the CARE2X software.

Data Collection and data analysis
Retrospective data were obtained from the study casts and OPG records of the patients to determine the number, type, location, and pattern of non-syndromic hypodontia. The same previously trained professional examined all the study casts and radiographs. All the data were analysed using Tooth Agenesis Code (TAC) data analysis method developed by Dr AJ Van Wijk, from Social Dentistry and Behavioural Sciences, Academic Centre for Dentistry Amsterdam (ACTA). The method uses the idea of binary arithmetic where the absence of tooth is represented by number one while zero represents the presence of tooth which will be translated into corresponding unique values (14). All data of 630 patients were uploaded to the website (http://www. toothagenesiscode.com/) and the result was recorded in Microsoft Word Office 365 for analysis.

RESULTS

The total number of patients evaluated for hypodontia was 630 patients (459 females, 171 males), in which 84 permanent teeth excluding third molars were found missing from 45 patients (33 Females, 12 males), with the average number of missing teeth per patient is 0.13+0.61. The prevalence of non-syndromic hypodontia is 7.1%. The patients were in the range of 7 to 34 years old when the pre-treatment OPGs were taken. The frequency of missing teeth per patient is shown in Table I, where a single tooth missing was found to be almost half (49.0%) of the total cases, and two cases were found to be oligodontia.

TABLE I: Frequency of missing tooth per patient (*n* = 45)

Number of missing teeth	Number of patients (*n*)	Percentage (%)
One	22	49.0
Two	18	40.0
Three	1	2.2
Four	1	2.2
Five	1	2.2
Six	1	2.2
Eight	1	2.2

The frequency of missing teeth in the maxilla and mandible arches were 48.8% and 51.2% respectively and three cases were having both unilateral and bilateral missing teeth either in the maxillary or mandibular arches. The missing teeth were predominantly higher on the left than the right side (Table II).

TABLE II: Frequency of missing teeth by jaw (*n* = 84), facial side/ location (*n* = 84) and pattern of the missing tooth (*n* = 56)

Variables/parameter	Number of teeth/ cases (*n*)	Percentage (%)
Jaw		
Maxilla	41	48.8
Mandible	43	51.2
Facial side/location		
Right	40	47.6
left	44	52.4
Pattern of the missing tooth		
Unilateral	26	46.4
Bilateral	30	53.6

Table III shows the distribution and frequency of missing teeth in the maxilla and mandible, where the most commonly missing teeth are maxillary lateral incisors (27.5%) followed by mandibular lateral incisors (24.0%), and maxillary second premolars (12.0%). In contrast, the least was mandibular first premolars (1.1%). No first molar teeth and maxillary central incisors were reported missing.

TABLE III: Distribution and frequency of missing teeth in the maxilla and mandible

Dental quadrant	Type of tooth						
	1	2	3	4	5	6	7
Maxillary							
Right	0	11	1	1	5	0	1
Left	0	12	3	1	5	0	1
Total number of maxillary teeth, n (%)	0 (0)	23 (27.5)	4 (4.8)	2 (2.3)	10 (12.0)	0 (0)	2 (2.3)
Mandibular							
Right	3	10	3	0	4	0	1
Left	3	10	4	1	3	0	1
Total number of maxillary teeth, n (%)	6 (7.1)	20 (24.0)	7 (8.3)	1 (1.1)	7 (8.3)	0 (0)	2 (2.3)

DISCUSSION

The prevalence of non-syndromic hypodontia excluding third molars among patients attending orthodontics clinic; 7.1 % is synchronous with the reported range of related hypodontia in permanent dentition cases excluding third molars within normal populations (2,7–10). However, the frequency is higher than the previous report in IIUM dental polyclinic patients; 1.0% (7). The high prevalence rate in this study supports the finding by Al-Jabaa AH et al. (2013) where teeth were more likely to be missing in orthodontic patients than the normal population. The samples collected from this study were from an orthodontic specialist clinic where most of the cases were referred by other general dental practitioners and some of the patients with hypodontia were more likely to seek orthodontic treatment due to teeth spacing. The sample size for studies focusing on orthodontic patients was usually smaller than the normal populations' study which also contributed to a higher prevalence of missing teeth.

The pattern of missing teeth, however, is different among populations, ethnicity, and countries. The prevalence of non-syndromic hypodontia excluding third molars among orthodontic patients was between 3.0% to 12.6% (6,11,15–21). The difference in the reported pattern and prevalence of hypodontia may be due to genetic variation among different populations and the total sample size studied.

A survey was done by Behr M et al. (2011) on 1353 orthodontic patients in Eastern Bavaria found that 171 patients have congenitally missing teeth where the sample size population was profoundly larger than the samples in this study. Another study on 3400 Brazilian orthodontic patients with a range of age between 8 to 30 years old reported that the prevalence of non-syndromic hypodontia was 3.0% (16) which is lower compared to the result from this study even though the sample size was huge. The genetic variation among different countries and populations might be the possible explanation for the findings.

In this study, the most frequent form of tooth missing is mild hypodontia, where a majority of the cases have congenitally missing one or two teeth. It is consistent with other reported studies in other countries and populations (9,20). Mild hypodontia also was found to be the most common form in Malaysia (7,13,22). There was no anodontia case reported in this current study. As suggested by Vahid-Dastjerdi E et al. (2010), patients with anodontia were most likely referred to paediatric dentistry or oral diagnosis clinic instead of orthodontic clinics. Patients with oligodontia also were most likely referred to paediatric dentistry, which may have contributed to the study's lower prevalence of severe hypodontia.

From this study, maxillary lateral incisors were identified to be the most commonly missing teeth. The result was supported by several studies where maxillary lateral incisors were found to be the most common missing tooth (13,15,16,19). However, other studies reported that mandibular second premolars were the most common tooth missing (6,18,21,23,24). Interestingly, in this study, the mandibular second premolar is the common tooth missing after mandibular lateral incisors and maxillary second premolars.

Hypodontia of maxillary central incisors seems to be a very rare occurrence in most of the populations studied (25). It is normally presented with syndromic conditions such as cleft lip/palate, ectodermal dysplasia, and Down syndrome. Congenitally missing maxillary permanent canine is usually rare (26) and only a few cases were reported. However, it was found that four cases of maxillary canine were found missing in this present study. The result is consistent with research among the Chinese population (27,28) and IIUM dental polyclinics patients (7). The variation in the number of cases reported could be due to racial differences in the pattern of hypodontia and may be comparatively more common in Asian people (27).

In this study, non-syndromic hypodontia is more prevalent in the mandible compared to the maxilla. The result is contrary to most of the studies done (7,9,15,29). Hypodontia also was found to be more on the left side than the right side, but the difference was very low, and it is in line with other reported studies among orthodontic populations across the countries (17,30,31)

where most of the missing teeth were found on the left side. However, other studies reported the opposite (7,8,10,13,20,29,30). It is still unclear why certain teeth were found missing on certain sides or in specific locations.

It is observed that bilateral missing teeth are more frequent than unilateral manifestations in this study. Symmetric hypodontia was more common than asymmetric hypodontia in bilaterally missing teeth which is consistent with other studies conducted in Malaysia and other countries (12,30,32–34) contributing to the higher prevalence of patients with bilaterally missing teeth. However, it was reported the opposite in other studies reported among Korean (20) and Portuguese populations (8). Bilateral missing of maxillary lateral incisors was identified as the most frequent one, followed by mandibular second premolars, while mandibular lateral incisors were commonly found unilaterally missing. It is, however, contrary to the reported study from IIUM dental polyclinic patients (7).

TAC analysis provides an insight into the pattern of hypodontia in orthodontic clinic by assigning numerical values for each hypodontia condition. The tool allows two types of datasets to be uploaded; separate elements and TAC values. The separate elements will be translated into TAC values by inserting the data as code 0 or 1 to represent the presence and absence of teeth. Findings reported by Souza-Silva BN et al. (2018) on the pattern and distribution of non-syndromic hypodontia using the TAC Values for each case portraying very detailed symmetric agenesis patterns, single tooth symmetry, and distribution of missing teeth across quadrants and the type of missing teeth. This procedure hence provides an easier data analysis over existing methods and allows researchers to be able to communicate clearly and unambiguously on their phenotypic studies (14).

CONCLUSION

This study shows that 7.1% of orthodontic patients in orthodontic clinic have non-syndromic hypodontia excluding third molars. The maxillary lateral incisors were the most frequently missing teeth, followed by mandibular lateral incisors and maxillary second premolars, while the prevalence is higher in the mandible than the maxilla. It is also observed that bilaterally missing tooth is more common than unilaterally missing teeth. This phenotypic research further confirms the need to ascertain the genotypic study of non-syndromic hypodontia among orthodontic patients.

ACKNOWLEDGEMENTS

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