OSR
ORAL SCIENCES REPORTS

Original Article


*Received: April 5, 2025*
*Revised: June 25, 2025*
*Accepted: October 7, 2025*

***Corresponding Author:***
Pavitra Waikasetkorn, Department of Orthodontics, Faculty of Dentistry, Bangkokthonburi University, Bangkok 10170, Thailand
E-mail: Pavitra.wai@bkkthon.ac.th

Oral Sci Rep. 2026; 47(2): 199-205

# Prevalence and Demographics of Non-Syndromic Tooth Agenesis on the Population of Orthodontic Patients

*Pavitra Waikasetkorn*[1], *Wandee Palanuparph*[1], *Yosananda Chantravekin*[2]

[1]*Department of Orthodontics, Faculty of Dentistry, Bangkokthonburi University, Thailand*
[2]*Department of Oral surgery, Faculty of Dentistry, Bangkokthonburi University, Thailand*

## Abstract

**Objectives:** To evaluate the prevalence of tooth agenesis (TA) and its association with gender, tooth type, and location. Additionally, to investigate the clinical features of TA in non-syndromic subjects attending the postgraduate orthodontic clinic at Bangkok thonburi University, Chiang Mai branch.

**Methods:** This study was conducted utilizing 1337 patients, 935 females and 402 males, aged 12-45 years. TA, demographic data, and clinical features were surveyed using their complete pretreatment records, study models, panoramic radiographs, and intra-oral photographs according to gender, tooth type, location (Maxillary/Mandibular arch), and their clinical features. The level of statistical significance was set at $p<0.05$ using Chi-Square tests and descriptive statistics.

**Results:** The study group included 82 patients (22 males, 60 females). A total of 129 teeth were missing, not including the third molars. TA was more prevalent in the mandible. The mandibular lateral incisor was the most frequently observed missing tooth. The clinical features of TA were also classified. Microdontia was found the most frequent in maxillary arch, whereas prolonged retention was found more in mandibular arch. The most common features of maxillary intra-arch relationship were crowding, whereas spacing was more prevalent in the mandibular arch. Regarding the features of inter-arch relationship, there were deep bite, followed by anterior crossbite, anterior protrusion, posterior crossbite, and open bite respectively.

**Conclusions:** A prevalence of 6.13% for TA was detected in this study. There are several clinical features involved in TA both intra and inter-arch relationship.

**Keywords:** clinical features, inter-arch relationship, intra-arch relationship, tooth agenesis

## Introduction

Tooth agenesis (TA) refers to the absence of teeth due to the absence of a tooth bud. It is one of the most common developmental anomalies in human dentition and occurs frequently across different ethnic groups, with the third molar being the most commonly missing tooth.[1] It can result from a disease, a syndrome associated with various systemic disorders (syndromic form), or from genetic abnormalities.[2,3] Additionally, environmental factors can influence TA. For instance, smoking and alcohol consumption during pregnancy are associated with a significantly higher prevalence of TA.[4,5]

TA can present in different forms, with its variability influenced by factors such as gender, age, race, and geographic location.[6] Previous studies have found that the prevalence of TA was 8.9% in Thais and the most commonly lost tooth was the mandibular second premolar.[7] The prevalence of TA ranges from 4.4% in Latin America, 5.0% in North America, 6.3% in Asia and Australia, and 13.4% in Africa.[8]

Recent studies have explored the prevalence and demographic data of TA.[3,6,9] However, there is still limited information regarding clinical features that may indicate TA. There are various types of malocclusions which are often associated with TA.[5] The following characteristics has been reported: The mandibular incisors are retroclined[10], retained primary teeth[1,11], ectopic permanent maxillary canines, transposition and rotation of teeth, and peg-shaped maxillary lateral incisors[1], disturbances in spacing of the dentition[11], shorter upper and lower dental arch lengths.[12] When retained primary teeth lack a permanent successor and are severely submerged, several clinical features may arise. These include underdevelopment of the alveolar process, absence of normal mesial drift, non-response to orthodontic forces, supra-eruption of opposing teeth, lateral open bite, and an increased occurrence of crossbites. Nonetheless, such disturbances have no long-term effects on occlusion.[13] Moreover, Becker and Shochat observed a significant shift in the dental midline toward the affected side.[14]

TA often poses a significant clinical challenge for orthodontists, as it may result in prolonged treatment duration and potentially compromised treatment outcomes in some cases.[15] Furthermore, early diagnosis of tooth agenesis is crucial, as it enhances the opportunity to address the child's dental issues from the initial oral examination through radiographic evaluation and appropriate treatment planning. Therefore, identifying the prevalence, demographic data, and clinical features of TA could be valuable for early detection and for guiding the development of future treatments.

This research was undertaken due to the current lack of comprehensive studies examining TA and its clinical features in Thai patients residing in Northern Thailand. This study aimed to evaluate the prevalence of TA and its association with gender, tooth type, and location. Additionally, to investigate the clinical features of TA in non-syndromic subjects attending the postgraduate orthodontic clinic at Bangkok Thonburi University, Chiang Mai branch.

## Materials and Methods

This retrospective study included patients' records, which were collected for diagnostic purposes, routinely taken prior to orthodontic treatment at the postgraduate orthodontic clinic at Bangkokthonburi University, Chiang Mai branch from August 2016 to December 2023. The study received ethical approval from the Human Experimental Committee of the Faculty of Dentistry, Bangkokthonburi University, Thailand (No.27/2024). The sample size was calculated from G power program using prevalence of TA in Thai population from previous study[9] with an alpha=0.05 and effect size=0.11.

Three examiners created a numerical code to identify patients without specifying their names to record data of patients, the number of TA patterns in gender, tooth type, location (Maxillary/Mandibular arch), and clinical features based on intra-arch and inter-arch. The data were collected from dental history records, intraoral photographs, digital study models, and panoramic radiographs under the supervision of two orthodontists. Panoramic radiographs, using an Orthophos S 3D (Dentsply Sirona, Bensheim, Germany) device and processed with its inbuilt software (Sidexis XG 2.61, Dentsply Sirona, Bensheim, Germany), were measured twice, one week apart, to ensure reliability and reduce examination bias. Intra-rater and inter-examiner reliability was then evaluated using Kappa statistics of 20 panoramic films.

The inclusion criteria were as follows: Thai national residences in the Northern Thailand, the patients with TA of one or more teeth, the patients with complete dental history records, intra-oral photographs, digital study

models, and panoramic radiographs before treatment. The exclusion criteria were as follows: Patients with systemic diseases, syndromes, unclear diagnoses of missing teeth on radiographs, or a history of dental trauma, extraction, or surgical treatment (excluding third molar) were excluded.

Associated clinical features of TA were also evaluated, including microdontia and prolonged retention. Other clinical features relating to intra-arch relationship were torsi version, spacing, infraocclusion, supraocclusion, crowding, and transposition. The clinical features of inter-arch relationship were deep bite, anterior crossbite, anterior protrusion, posterior crossbite and open bite. All statistical analyses were conducted using IBM SPSS statistics for Windows, Version 25 (IBM Corp., Armonk, NY, USA). The independent variables are TA, whereas the dependent variables are gender, tooth type, location (Maxillary/Mandibular arch) and all clinical features. Descriptive statistics were used to present the patient characteristics. For inferential statistic, the Chi-square test was employed to evaluate the association between gender, tooth type, location, and TA. The level of statistical significance was set at $p<0.05$. The examination, evaluation, and analysis process were summarized in the workflow diagram as shown in Figure 1.

## Results

Both intra-examiner and inter-examiner agreements in this study were nearly perfect (using Cohen's Kappa Coefficient statistic value equal 1). A total of 1337 previous dental history, panoramic radiographs, digital model, and intra-oral photographs of healthy patients aged 12-45 years, 935 females and 402 males were examined. Non-syndromic TA in the permanent dentition (excluding third molars and patients without study models) was diagnosed in 82 subjects, with a total of 129 missing teeth. The overall prevalence of TA was found to be 6.13%. The prevalence of TA was higher in females than males (6.42% and 5.47%, respectively) as shown in Table 1.

The most prevalent TA was lateral incisor (58.91%;

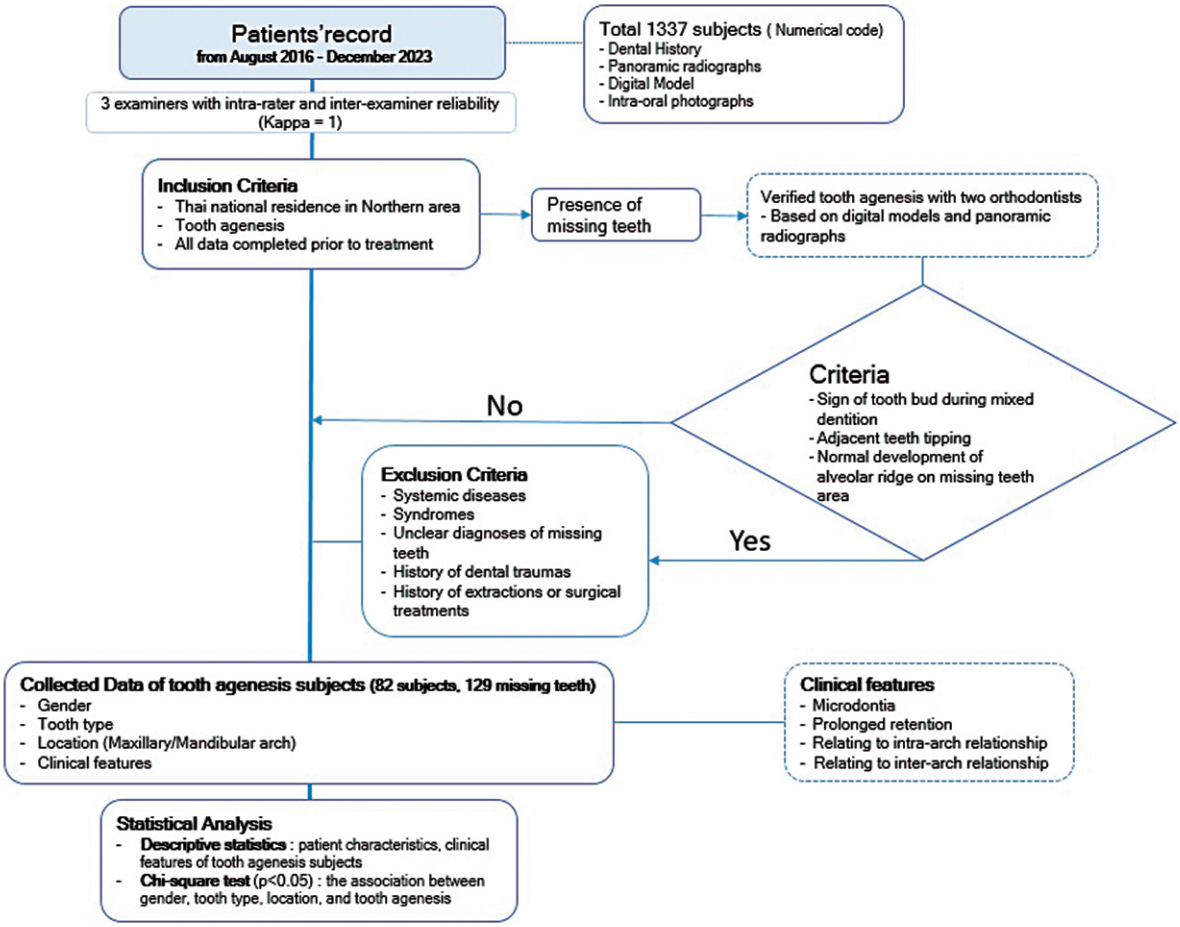


**Figure 1:** Workflow diagram for examination, evaluation, and analytical procedures.

n=76), followed by second premolars (23.25%; n=30), central incisors (8.53%; n=11), first premolars (6.97%; n=9), and canines (2.32%; n=3), respectively. There was no missing first and second molars. When the missing teeth were examined separately according to the dental arches, TA was more prevalent in the mandibular arch (69%) than in the maxillary arch (31%). However, no statistically significantly difference was observed between dental arches, as shown in Table 2.

Thirteen clinical features were selected for evaluation. Microdontia was most frequently observed in the maxillary arch (n=17) and was not found in the mandibular arch. Whereas prolonged retention was found more in the mandibular arch (n=7) than in the maxillary arch (n=1). Regarding the distribution of clinical features based on arch relationships, the most common feature observed in the maxillary intra-arch relationship was crowding (n=17), while spacing (n=21) was the predominant feature in the mandibular intra-arch relationship, as shown in Figure 2.

Regarding the features of inter-arch relationship between maxillary and mandibular arches, the most common feature was deep bite (32.9%), followed by anterior crossbite (21.1%), anterior protrusion and posterior crossbite (18.4% each), and open bite (9.2%), as shown in Figure 3.

## Discussion

This study is an epidemiological investigation of TA observed in patients at a university postgraduate orthodontic clinic. As a result, the prevalence rate of this agenesis found in the study may not directly represent that of the general population.

While the prevalence of TA has been widely studied in various populations, it remains an area of ongoing research. In Thailand, however, research on this topic is limited. Previous research by Kanchanasevee *et al*.,[7] and Tantanapornkul[16] relied solely on data obtained from panoramic radiographs. However, this study collected data from dental history, digital dental models, intraoral photographs in addition to panoramic radiographs. Therefore, the results provided greater precision regarding missing tooth types and revealed related clinical features beyond the capabilities of panoramic radiographs alone.

Prevalence of TA in this study was 6.13% which was lower than other studies reported in other regions of Thailand. Differences in results among studies could potentially occur from variations in the demographic characteristics (e.g., regional origin, ethnicity) of the investigated populations, as well as methodological disparities such as sampling techniques and diagnostic criteria. Research has indicated that excluding the absent third molar can enhance the reliability of studies,

**Table 1:** Distribution of prevalence rate of tooth agenesis by gender.

| | Number of Patients | | | |
|---|---|---|---|---|
| **Sex** | **Sample** | **Affected** | **Prevalence (%)** | ***p*-value** |
| Male | 402 | 22 | 5.47 | |
| Female | 935 | 60 | 6.42 | 0.53 |
| Total | 1337 | 82 | 6.13 | |

**Table 2:** Distribution of tooth agenesis by tooth type in relation to maxillary and mandibular arches.

| Tooth type | Maxillary arch, n(%) | Mandibular arch, n(%) | Total, n(%) | *p*-value |
|---|---|---|---|---|
| Central incisor | 1 (2.50) | 10 (11.24) | 11 (8.53) | 0.171 |
| Lateral incisor | 21 (52.50) | 55 (61.79) | 76 (58.91) | 0.321 |
| Canine | 1 (2.50) | 2 (2.25) | 3 (2.33) | 1.000 |
| First premolar | 6 (15.00) | 3 (3.37) | 9 (6.98) | 0.250 |
| Second premolar | 11 (27.50) | 19 (21.34) | 30 (23.25) | 0.444 |
| First molar | 0 (0) | 0 (0) | 0 (0) | NA |
| Second molar | 0 (0) | 0 (0) | 0 (0) | NA |
| Total | 40 (100) | 89 (100) | 129 (100) | 0.070 |

*p*-value from Chi-square: Comparison on affected/ non affected subjects and Maxilla/Mandible in each tooth type.

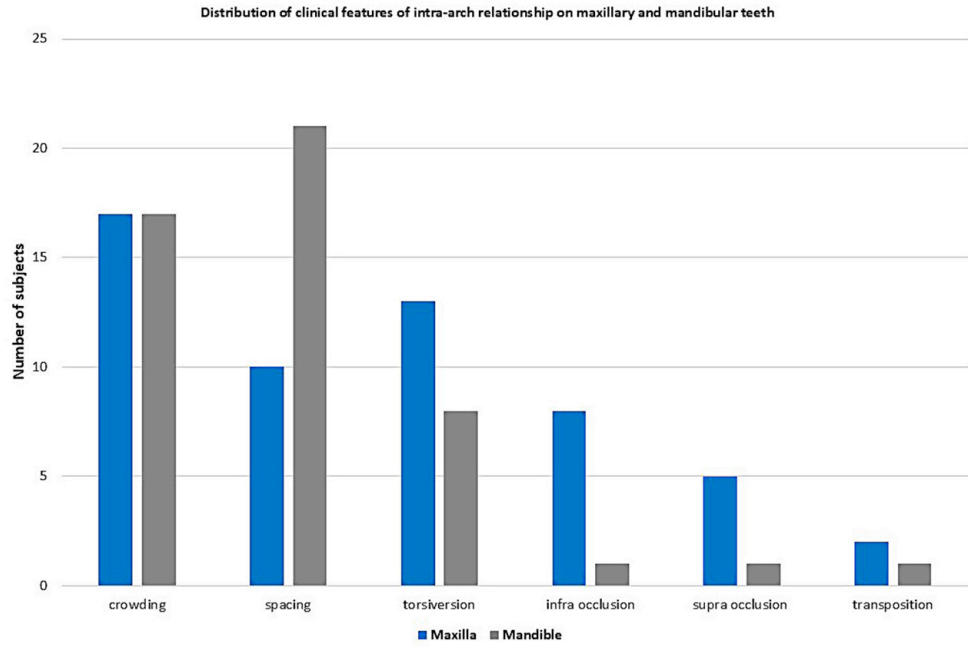


**Figure 2:** Distribution of clinical features of intra-arch relationship on maxillary and mandibular teeth.

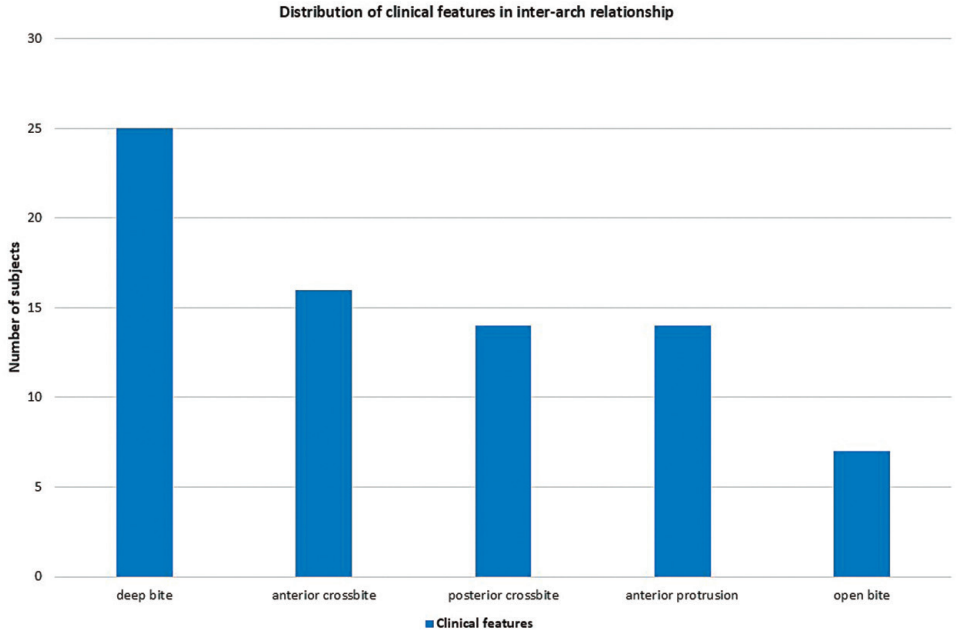


**Figure 3:** Distribution of clinical features in inter-arch relationship.

as the total number of patients with hypodontia rises by 27-30.6% when the third molar is considered missing.[17] Therefore, third molars were excluded from this study.

The study of Sisman *et al*[18], Hobkirk *et al*[19], Polder *et al*[20], Kanchanasevee[9], as well as the present study found that the incidence of TA was higher in females than in males, although the difference was not statistically significant. This aligns with previous findings suggesting a higher proportion of female orthodontic patients[21], with females comprised 69.9% of the sample in this study. Moreover, no statistically significant difference was observed between genders regarding the distribution of missing teeth in the maxilla and mandible. However, this study reported a nearly twofold higher prevalence of missing teeth in the mandible (68.9%) compared to the maxilla (31.1%), which is consistent with the findings of

Kanchanasevee *et al.*,[9] and Tantanapornkul.[16] These differences may be attributed to variations in jaw development (ontogenesis), particularly between the mandible and maxilla, which could contribute to the higher frequency of missing teeth and other dental anomalies in the mandibular arch.[22]

In previous articles, the most reported missing teeth are the second premolars, lateral incisors, and first premolars.[6,21,23] On the other hand, this study reported that the most prevalent missing tooth was mandibular lateral incisors followed by maxillary lateral incisors and mandibular second premolars, respectively. The absence of first and second molars was consistent with findings from previous studies on TA.[8] From an evolutionary perspective, the congenital absence of teeth in humans is not surprising, and this change is influenced by various genes. Mutations in the MSX1, PAX9, AXIN2, and EDA genes are causative factors in non-syndromic TA.[24]

TA is usually linked to several clinical features, including the location of the agenesis and the size of the neighboring teeth such as microdontia, delayed dental development, prolonged retention, and some tooth ectopia, possibly because a certain genetic mutation causes a series of different phenotypes expression.[25] Microdontia and hypodontia represent a genetic continuum of tooth size. If a tooth germ doesn't reach a critical size threshold, the tooth fails to develop, resulting in hypodontia.[26] The previous studies did not investigate the clinical features relating to tooth agenesis.[9,27,28] Whereas this study also investigated another point of view; the clinical features which are presented in terms of inter-arch and intra-arch relationships. For intra-arch relationships, the two-highest prevalence was crowding and spacing which is in agreement with previous studies which demonstrated that it is common to observe generalized spacing and rotations of the teeth next to missing mandibular second premolars.[29]

For inter-arch relationships, this study found that deep bite had the highest prevalence among the clinical features observed. Moreover, hypodontia was found to be approximately twice as common in the mandibular arch compared to the maxillary arch. This clinical feature may be related to the mismatch in the number of teeth, which affects the deficient ratio in Bolton's analysis, leading to a deep overbite and large overjet. Herrera-Atoche *et al.*, reported a tendency for the lower incisors to be retroclined, positioned more extrusively, and associated with a deeper bite compared to controls. It appears that, in patients with posterior tooth agenesis (TA), the bite deepens as a result of lower incisors extrusion.[30] The second most common inter-arch anomaly identified was anterior crossbite in this study. Wisth also found that children with hypodontia often exhibit a shorter, more retrusive maxillary arch and proclined upper incisors.[31]

Therefore, detection of TA during the mixed dentition stage allows orthodontists and pediatric dentists to implement appropriate treatment strategies, such as space maintenance or redistribution, to achieve optimal dental function and aesthetics. Further studies are recommended to explore the association between TA and dental as well as skeletal discrepancies in order to enhance clinical understanding and improve treatment planning.

## Conclusions

In this study, the prevalence of permanent TA was 6.13%, which was lower than the previously reported rates of 8.6-9.7% conducted on Thai population. Single TA was the most common pattern, occurring 58.53% of affected cases, with mandibular lateral incisors being the most frequently missing teeth. We found that there are several clinical features involved with TA in both inter-arch and intra-arch relationships.

## Conflict of Interest

The authors declare no conflict of interest.

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