

## Altered Passive Eruption: Morphological Characteristics Based on Cone-Beam Computed Tomographic Images

Truong Nhut Khue, Huynh Thi Ngoc Thanh, Nguyen Thi Tuong Van, Do Thi Thao\*

Faculty of Odonto and Stomatology, Can Tho University of Medicine and Pharmacy, Vietnam

### ABSTRACT

**Objective:** This descriptive cross-sectional study aimed to characterize the morphological and periodontal features of altered passive eruption maxillary anterior teeth to better target the treatment method for individual patients.

**Methods:** 38 patients (27 females and 11 males) with altered passive eruption (APE) type 1 were included. Teeth and periodontal parameters were measured on study casts and cone-beam computed tomographic images.

**Results:** The width/length ratios of the central incisors, lateral incisors, and canines were 1.06, 1.02, and 1.03 mm, respectively. The mean distance between the cement–enamel junction and the alveolar bone crest was <1.5 mm. Thick gingival tissue was observed in 68.4% of the sample, and the buccal alveolar bone thickness was >1 mm. P values of less than 0.05 were considered statistically significant.

**Conclusion:** No association between gingival tissue thickness and alveolar bone thickness was observed. The clinical and anatomical crown lengths of the three tooth groups of men were larger than those of women, but the difference was significant only for canines. Clinical examination combined with cone-beam computed tomographic images can be used in the diagnosis and treatment planning of APE. The aim of treatment is to restore the optimal biological width and reestablish the correlation between gingiva, tooth, and bone tissue.

**Key words:** Altered passive eruption, Cone-beam computed tomography, Gingivectomy, Apically positioned flap

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**Corresponding author:** Do Thi Thao

**e-mail** ✉: dtthao@ctump.edu.vn

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### INTRODUCTION

Tooth eruption consists of two phases, a phase in which the tooth emerges into the oral cavity, called the active phase, and a phase that is typified by apical migration of the soft tissue covering the crown of the tooth, called the passive phase [1]. Coslet first described the term “altered passive eruption” (APE) in 1977. APE occurs when the gingiva partially covers the crown, resulting in a short clinical crown. This causes disharmony between the tooth and the face because the visible part of the tooth has an undesirable shape, appearing almost square. Furthermore, excessive gingiva that extends beyond the lower edge of the upper lip can produce a distinct gummy smile [2,3]. APE can be a physiological

or pathological condition that requires intervention to achieve the patient's maximum aesthetics and function [4].

Patients have become increasingly aware of APE, and demand for treatment has been growing [5]. In 1976, Volcansky and Cleaton-Jones showed that among 1025 patients with an average age of 24.2+6.2 years, 12.1% had passive eruption changes [6]. According to a 2014 study in Spain, the APE rate had increased to 29.5% [4]. APE has been one of the main indications for crown-lengthening surgical procedures [7].

Smile aesthetics result from many factors, among which dental aesthetics and the environment play important roles [8,9]. The term “gummy smile” is applied when more than 2 mm of the maxillary gingival is visible when smiling [10]. Maxillary anterior teeth have been considered to be key components that can either hinder or improve the aesthetic appearance of the smile [11]. One potential cause of excessive gingival display is APE [12]. For APE type 1A cases, the primary treatment option is simple gingivectomy to expose the hidden structures, while for other APE types, an apically repositioned full-thickness flap with or without osseous resective surgery may be required [13,14].

**MATERIALS AND METHODS**

This descriptive cross-sectional study was performed in accordance with the Declaration of Helsinki. All clinical procedures and data analyses conducted for this study were conducted in patients with APE who attended the Hospital of Can Tho University of Medicine and Pharmacy between 2017 and 2019.

**Selection criteria**

Patients were consecutively enrolled in the study if all the following inclusion criteria were met: 18 years or older; presence of APE type I with crown-covering gingiva and short crown with square shape; width/length ratio >0.85; keratinized gingival height >3–5 mm [15], presence of six maxillary anterior teeth; no abnormalities of tooth shape; and systemically healthy.

The exclusion criteria were as follows: patient with removable or fixed prosthodontics appliances; previous maxillofacial surgery; injuries of maxillary anterior alveolar and teeth; presence of maxillofacial defects, rotated, or crooked teeth; presence of malocclusion, diastema, tooth wear, or unstable periodontitis.

**Clinical assessment**

The following clinical parameters were measured: width, length, and width/length ratio of the clinical crowns, measured on the dental cast; length of the anatomical crowns, measured on cone-beam computed tomographic (CBCT) images; keratinized gingiva height, free gingiva height, attached gingiva height, and gingival display during maximal smiling, measured on clinical assessment; distance between the cement–enamel junction (CEJ) and alveolar bone crest (ABC), alveolar bone thickness (ABT), and gingival thickness, measured on CBCT images.

**Clinical procedures and CBCT protocol**

Patients were evaluated through a periodontal examination. Study casts were obtained for all subjects. The width, length, and width/length ratio of the clinical crowns were measured from the study cast with the aid of a digital caliper. The length of the anatomical crowns, the distance between the CEJ and alveolar crest, the ABT,

and the gingival thickness were recorded using a Sirona Galileos CBCT system (Sirona Dental Systems, Bensheim, Germany).

**Data analysis**

A subject-level analysis was performed for each parameter. Descriptive statistics were performed using the mean ± standard deviation for quantitative variables and percentage for qualitative variables. The Mann–Whitney U test and Spearman’s correlation analysis were performed to assess whether there were differences in the data sets between men and women. P ≤ 0.05 was considered statistically significant. Statistical procedures were carried out in SPSS version 24.0 (IBM).

**RESULTS**

**General characteristics of the study subjects**

The study included 38 patients, 27 (71.1%) women and 11 (28.9%) men ages 18 to 29 years, with a mean age of 23.89 ± 2.49 years.

**Teeth characteristics**

The anatomical and clinical crown lengths are summarized in Table 1. The maxillary anterior teeth including central incisors, lateral incisors, and canines had mean clinical crown lengths of 8.09, 7.09, and 7.84 mm, respectively, and anatomical crown lengths of 10.17, 8.94, and 9.47 mm respectively. The clinical and anatomical crown lengths of the three tooth groups were larger in men than in women. The difference was significant in the canine group.

The width/length ratios of the central incisor clinical crowns in males and females were 1.05 mm and 1.07 mm; for lateral incisors the ratios were 1.00 mm and 1.02 mm, and for canines they were 1.00 mm and 1.04 mm, respectively (Table 2). The differences between males and females were not significant.

The mean clinical crown widths of central incisors, lateral incisors, and canines were 8.49, 7.12, 8.00 mm, respectively (Table 3). The correlation between the anatomical crown lengths of the lateral incisors and canine teeth was estimated based on standard ratios and

**Table 1: Anatomical and clinical crown lengths of maxillary anterior teeth by sex.**

Sex	Tooth group					
	Central incisors		Lateral incisors		Canines	
	Clinical	Anatomical	Clinical	Anatomical	Clinical	Anatomical
Male	8.30 ± 1.10 mm	10.38 ± 0.83 mm	7.32 ± 0.97 mm	9.15 ± 0.72 mm	8.26 ± 0.83 mm	9.79 ± 0.68 mm
Female	8.00 ± 0.67mm	10.09 ± 0.55 mm	6.99 ± 0.71 mm	8.56 ± 0.41 mm	7.68 ± 0.76 mm	9.33 ± 0.64 mm
Total	8.09 ± 0.82mm	10.17 ± 0.65 mm	7.09 ± 0.79 mm	8.94 ± 0.53 mm	7.84 ± 0.81 mm	9.47 ± 0.68 mm
p	0.412	0.24	0.334	0.281	0.07	0.05

Mann–Whitney U test

**Table 2: Width/length ratios of maxillary anterior teeth clinical crowns by sex.**

Sex	Tooth group		
	Central incisors	Lateral incisors	Canines
Male	1.04 ± 0.12 mm	1.00 ± 0.13 mm	1.00 ± 0.07 mm
Female	1.07 ± 0.08 mm	1.02 ± 0.11 mm	1.04 ± 0.08 mm
Total	1.06 ± 0.09 mm	1.02 ± 0.12 mm	1.03 ± 0.08 mm

**Table 3: Anatomical crowns lengths of maxillary anterior teeth estimated on CBCT images\*.**

Tooth group	Width	Estimated length	Length on CBCT images	Difference	r
Central incisors	8.49 ± 0.44 mm	10.88 ± 0.57 mm	10.17 ± 0.65 mm	0.71 ± 0.72 mm	0.257
Lateral incisors	7.12 ± 0.48 mm	9.12 ± 0.62 mm	8.94 ± 0.53 mm	0.18 ± 0.81 mm	0.050
Canines	8.02 ± 0.42 mm	10.28 ± 0.54 mm	9.47 ± 0.68 mm	0.81 ± 0.55 mm	0.562

Spearman's coefficient (p) was used for the assessment of estimated length and length on CBCT images

**Table 4: Periodontal tissue characteristics of maxillary anterior teeth.**

Periodontal parameter	Sex		
	Male	Female	Total
Keratinized gingiva height	5.70 ± 0.67 mm	5.74 ± 0.56 mm	5.73 ± 0.58 mm
Attached gingiva height	4.23 ± 0.61 mm	4.17 ± 0.62 mm	4.18 ± 0.61 mm
Free gingiva height	1.47 ± 0.45 mm	1.57 ± 0.53 mm	1.55 ± 0.50 mm
Gingival display during maximal smiling $\bar{g}$	3.82 ± 0.87 mm	4.33 ± 0.96 mm	4.18 ± 0.95 mm

P ≤ 0.05 was considered statistically significant

**Table 5: Distance between the CEJ\* and ABC $\ddagger$ , and alveolar bone thickness on CBCT images $\S$ .**

Characteristic	Tooth group		
	Central incisors	Lateral incisors	Canines
CEJ to ABC distance	1.32 ± 0.64 mm	1.47 ± 0.51 mm	1.47 ± 0.65 mm
ABT**	1.04 ± 0.23 mm	1.07 ± 0.24 mm	1.26 ± 0.43 mm
*Cement-enamel junction			
†Alveolar bone crest			
$\ddagger$ Cone beam computed tomographic images			
$\S$ Alveolar bone thickness			

CBCT images.

**Periodontal tissue characteristics**

The characteristics of the periodontal tissues are presented in Table 4 and Table 5. The CEJ to ABC distance was <1.5 mm on average in all three groups of teeth. The distance was 1.32 ± 0.64 mm for central incisors, 1.47 ± 0.51 mm for lateral incisors, and 1.47 ± 0.65 mm for canines. The average ABT was >1 mm, and 68.4% of the study sample (26 people) had thick gingival tissue. There was no relationship between ABT and gingival tissue thickness.

**DISCUSSION**

**Teeth characteristics**

Altered passive eruption was found in many of the study participants, with females accounting for 71.1%. All participants were adults aged 18 to 29 years. Dental aesthetics can be a concern for this demographic group. We chose this age group because the size of their teeth is considered to have stabilized.[5] If the patient is too young, the teeth may not have fully erupted. If the patient is too old, there will be tooth wear on the incisal edge and approximal surface, which will affect the accuracy of the measurement results.

We found that tooth size differed between males and females, with males having larger teeth; however, the difference was significant only in the canine group.

The teeth characteristics measured in our study were compared with the findings of previous studies. From the CBCT images, the anatomical crown lengths of

the middle incisors, lateral incisors, and canines were 10.17, 8.94, and 9.47 mm, respectively. These results were similar to those of Batista (2012) who found anatomical and clinical crown lengths of 9.24 mm and 6.94 mm for middle incisors, 7.64 mm and 5.64 mm for lateral incisors, and 8.64 mm and 6.90 mm for canines. [2] The findings of Batista resulted in larger clinical crown width/length ratios than the standard ratio. In 1999, Sterrett proposed using the clinical crown width/length ratio to estimate the anatomical crown length. [16] However, this method was not accurate because it depends on many factors related to the population and geography. CBCT allows us to obtain an accurate anatomical crown length and estimate the reduction in the CEJ to the ABC distance. Some authors incorporate osseous resection as part of clinical crown lengthening surgery.[17] However, we should only resect the alveolar bone if the distance from the CEJ to the ABC is <1.5 mm.

**Periodontal tissue characteristics**

A gummy smile is often associated with dissatisfaction with the smile appearance and is found in 10.5% to 29% of the population.[18] In the study sample, the average gingival display during maximal smiling was 4.18 mm, of which the highest was 6 mm. APE is one of the causes of gingival smile, and its main treatment method is gingivectomy or creating an apically positioned flap with or without osseous resective surgery.[14, 19] The choice of treatment depends on the height of the keratinized gingiva and the CEJ to ABC distance. Gingivectomy should be planned specifically to avoid the removal of too much or too little gingival tissue. Osseous resective surgery should be planned when the CEJ to ABC distance is less than 1.5 mm. The outcome of the surgery depends on the relationship between the gingiva and bone tissue. The diagnosis and treatment of APE should be based on clinical and radiological evaluation.[20]

The study results showed that the subjects had a considerable keratinized gingival height with an average of 5.73 mm, and there was no significant difference between males and females. The primary treatment choice was gingivectomy. These findings are similar to those of Batista (2012) on 84 APE teeth.[2] In the current

study, 68.4% of subjects had thick gingival tissue, and an average ABT >1 mm was one of the factors favoring surgical treatment. Alveolar bone height measurements are more accurate in thick bone than in thin bone. To prevent periodontal damage, care must be taken to avoid exposure of the periodontal ligament after osseous resective surgery.

### CONCLUSION

Regarding teeth characteristics, the clinical and anatomical crown lengths were larger in men than in women, but the differences were not significant. The anatomical crown length could be estimated based on the crown width. There was a correlation between the estimated length and the length determined from the CBCT images for the lateral incisors and canines.

Regarding the periodontal tissue characteristics, the average keratinized gingival height was 5.73 mm with predominant thick gingival tissue (68.4%), ABT was >1 mm, and the average CEJ to ABC distance was <1.5 mm.

A comprehensive clinical examination combined with CBCT imaging can enable an accurate diagnosis of the APE classification and the selection of appropriate treatment. The primary aim of treatment is to restore the optimal biological width and reestablish the correlation between gingiva, teeth, bone tissue.

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