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MMP12

Relationship between the Midpalatal Suture Maturation, Cervical Vertebral Maturation and Dental Age in 8-18 Years Old Patients

ความสัมพันธ์ระหว่างการเจริญเติบโตของรอยประสานกระดูกกลางเพดานปาก การเจริญเติบโตของกระดูกสันหลังส่วนคอ และอายุฟัน ในกลุ่มผู้ป่วยอายุ 8-18 ปี

Nopparat Chutasripanich (นพรัตน์ จูฑศรีพานิช)* Korapin Mahatumarat (กรพินท์ มหาทุมะรัตน์)**

Dr.Soontra Panmekiate (ดร.สุนทรา พันธุ์มีเกียรติ)**

ABSTRACT

The aim of this study was to evaluate the relationships between the midpalatal suture maturation, cervical vertebral maturation (CVM) and dental age in 8-18 years old patients. 103 patients who had cone-beam computed tomographic (CBCT) images displaying the entire midpalatal suture and had lateral cephalometric radiograph or panoramic radiograph within 3 months from the date of CBCT were selected. The developmental stages of the midpalatal suture, CVM and dental age were determined and investigated the relationships using Spearman's rank correlation analysis. There was no correlation between the midpalatal suture maturation and CVM. However, the midpalatal suture maturation showed significant correlation with dental age. The mandibular second premolar showed the highest significant correlation coefficient with the midpalatal suture maturation.

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างการเจริญเติบโตของรอยประสานกระดูกกลางเพดาน ปาก การเจริญเติบโตของกระดูกสันหลังส่วนคอ และ อายุฟัน ในกลุ่มผู้ป่วยอายุ 8-18 ปี จำนวน 103 คน โดยประเมินการ เจริญเติบโตของรอยประสานกระดูกกลางเพดานจากภาพรังสีตัดขวางคอมพิวเตอร์ทางทันตกรรม ประเมินการเจริญเติบโต ของกระดูกสันหลังส่วนคอจากภาพถ่ายรังสีกะโหลกศีรษะด้านข้าง และประเมินอายุฟันจากภาพถ่ายรังสีพานอรามิก จากนั้นวิเคราะห์หาความสัมพันธ์โดยใช้สถิติสัมประสิทธิ์สหสัมพันธ์สเปียร์แมน พบว่าการเจริญเติบโตของรอยประสาน กระดูกกลางเพดานปากไม่สัมพันธ์กับการเจริญเติบโตของกระดูกสันหลังส่วนคอ แต่สัมพันธ์กับอายุฟัน โดยฟันกรามน้อย ล่างซี่ที่สองมีความสัมพันธ์กับการเจริญเติบโตของรอยประสานกระดูกกลางเพดานปากมากที่สุด

*Student, Higher Graduate Diploma of Clinical Sciences Program in Orthodontics, Department of Orthodontics, Faculty of Dentistry, Chulalongkorn University

**Associate Professor, Department of Orthodontics, Faculty of Dentistry, Chulalongkorn University

การประชุมวิชาการเสนอผลงานวิจัยระดับบัณฑิตศึกษาแห่งชาติ ครั้งที่ 21
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Introduction

Maxillary transverse deficiency may be one of the most common skeletal problems among orthodontic patients (McNamara, 2000). The most desirable method of treatment would be to correct the discrepancy at skeletal level (Haas, 1965). Rapid maxillary expansion (RME) is an orthopedic treatment that have been used to expand the maxillary arch and increase the maxillary transverse width (Haas, 1965; Liu et al., 2015; McNamara, 2000). The objective of RME is to split the midpalatal suture by using heavy force from expansion device (Haas, 1965). The success of RME treatment depends on skeletal maturity of the patient (Baccetti et al., 2001). The interdigitation of the midpalatal suture increases as it matures, making maxillary expansion even more difficult (Melsen, 1975). Closure of the craniofacial sutures and the midpalatal suture eventually make skeletal expansion by conventional RME impossible (Liu et al., 2015). Thus, surgically assisted rapid maxillary expansion (SARME) might be necessary (Chrcanovic and Custódio, 2009).

When performing RME, it is important to know the stage of maturation of the midpalatal suture. Generally, occlusal radiograph was used to determine the status of the midpalatal suture. However, the superimposition of adjacent anatomical structure made it unreliable for analyzing the midpalatal suture status (Wehrbein and Yildizhan, 2001). Currently, cone-beam computed tomographic (CBCT) image is used to assess the midpalatal suture maturation (Angelieri et al., 2013). The diagnostic advantage of CBCT over traditional occlusal radiograph is its ability to visualize the midpalatal suture in 3 dimensions without any overlapping of adjacent structures (Liu et al., 2015). However, it is not appropriate to take CBCT radiography of every patient because of radiation exposure and ethical concern.

In orthodontics, various skeletal maturity indices have been used to determine the physiologic maturation of patient such as hand and wrist method, cervical vertebrae maturation (CVM) and dental age. Although hand and wrist radiograph is considered to be a standard method for assessment of skeletal maturation (Hägg and Taranger, 1980), it requires additional radiograph. The CVM was assessed on lateral cephalometric radiographs and dental age was assessed on panoramic radiographs. These films are used routinely in orthodontic practice, thus avoiding the need for an additional radiograph (Baccetti et al., 2005). There were limited studies in the literature that evaluated the relationship between midpalatal suture maturation and other maturity indices, and the results were inconsistent.

Objectives of the study

The aim of this study is to evaluate the relationship between the maturation stage of midpalatal suture, CVM and dental age.

Methodology

The Human Research Ethics Committee of the Faculty of Dentistry, Chulalongkorn University has approved the study protocol. The sample in this study consisted of 103 subjects (44 males, 59

females, mean age 14.36 ± 2.7 years). Patients aged between 8 and 18 years old who underwent CBCT at the Department of Radiology, Faculty of Dentistry, Chulalongkorn University between January 2013 and December 2018 and met the inclusion criteria were retrospectively selected.

The inclusion criteria were patients who had CBCT images displaying the entire midpalatal suture, and also had lateral cephalometric radiograph or panoramic radiograph within 3 months from the date of CBCT, no missing mandibular permanent teeth except the third molars. Subjects with prior orthodontic treatment, orofacial cleft, craniofacial syndromes, history of trauma in the maxillofacial region or pathology in maxilla that might affect the midpalatal suture were excluded.

Assessment of the midpalatal suture maturation

The CBCT images were acquired using a 3D Accuitomo 170 machine (J. Morita, Kyoto, Japan) with 80-90 kVp, 1-10 mA and 17.5 s scanning time. The patient's head position was adjusted using Infinitt® PACs software (Infinitt Healthcare Co., Ltd., Seoul, Korea). In the coronal and axial views, the vertical reference line was positioned at the midsagittal plane. In the sagittal view, the horizontal reference line was adjusted so that it was centered in the supero-inferior dimension and passed through anteroposterior long axis of the palate (Fig. 1). The classification of the midpalatal suture maturation stage was performed on the cross-sectional axial slice and classified into 5 stages of maturation (A, B, C, D or E) according to the method of Angelieri et al. (Angelieri et al., 2013) (Fig. 2). For subjects who had a thick or curved palate, two axial cross-sectional slices were assessed.

Figure 1 Orientation of head position in 3 planes. A, axial; B, sagittal; and C, coronal views.
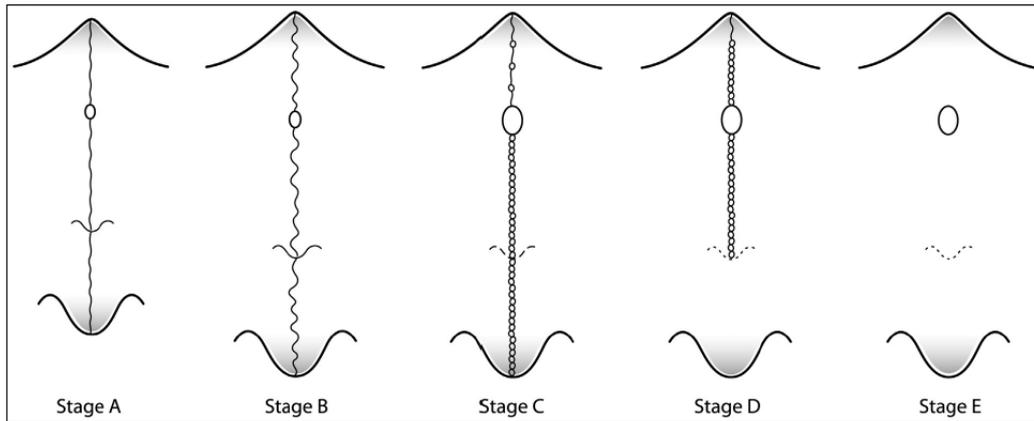
Stage A   Stage B   Stage C   Stage D   Stage E

Figure 2 The midpalatal suture maturation stages according to Angelieri et al. (Angelieri et al., 2013)

Assessment of cervical vertebrae maturation (CVM) and dental age

The CVM was evaluated from lateral cephalometric radiograph and classified into 6 stages (CS1-CS6) according to the method that was previously described by Baccetti et al. (Baccetti et al., 2005) (Fig. 3).

The dental development was assessed by using panoramic radiograph. The developmental stages of the left mandibular permanent teeth except the mandibular third molar were rated on a scale A to H and conversed to dental age according to the method of Demirjian et al. (Demirjian et al., 1973) (Fig. 4).
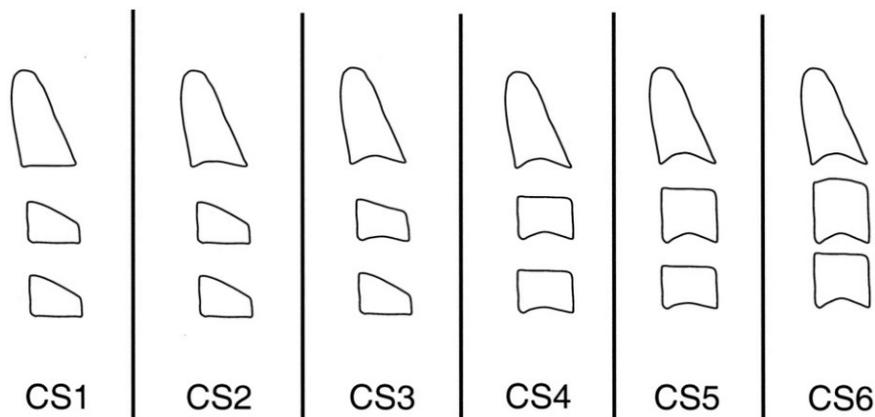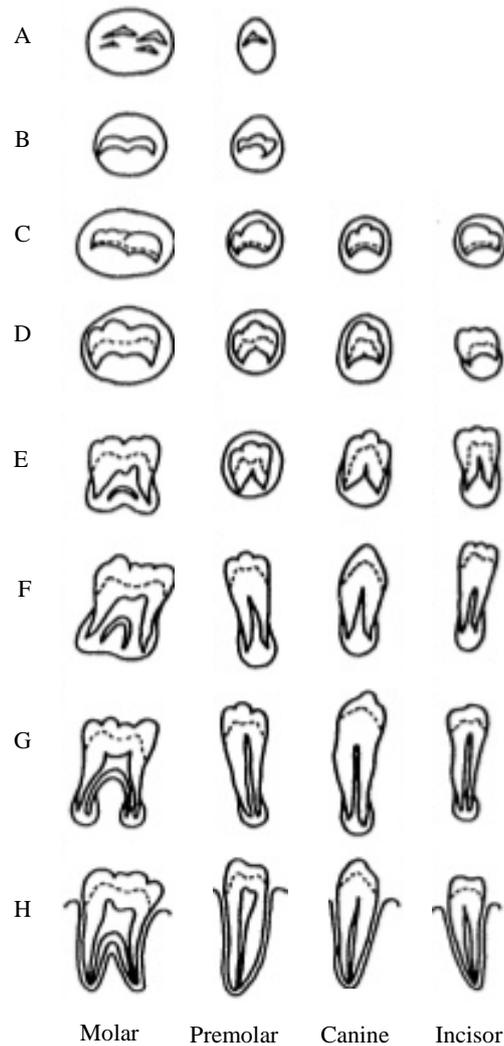

CS1   CS2   CS3   CS4   CS5   CS6

Figure 3 The stages of cervical vertebrae according to Baccetti et al. (Baccetti et al., 2005)

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A

B

C

D

E

F

G

H

Molar   Premolar   Canine   Incisor

Figure 4 Developmental stages of permanent teeth according to Demirjian et al. (Demirjian et al., 1973)

Statistical analyses were performed by using the Statistical Package for the Social Sciences (SPSS 22.0; IBM Corp, Armonk, NY). The mean age and standard deviation of each midpalatal suture maturation stage was calculated. The Spearman's rank order correlation analysis was used to investigate the relationship between the midpalatal suture maturation stages, CVM, dental age, and dental maturity of individual teeth. The level of significance was set at $p < 0.05$ for all statistical calculations.

Results

The distribution of subjects according to the stage of midpalatal suture maturation, mean age and standard deviation of each stage are presented in Table 1. The mean chronological age increases as the maturation stage of the midpalatal suture increases except for stage A.

Correlation coefficients between midpalatal suture maturation and other maturity indices are illustrated in Table 2. No significant correlation was observed between the midpalatal suture maturation stage and CVM (r = 0.244, p = 0.098). However, there was significant correlation between the midpalatal suture maturation stage and dental age (r = 0.279, p = 0.007). The correlation coefficients of the evaluated teeth ranged from 0.242 to 0.332 (p < 0.05). Mandibular second premolar showed highest correlation (r = 0.332, p = 0.001), and mandibular first premolar showed lowest correlation (r = 0.242, p= 0.021).

Table 1 Distribution of the midpalatal suture maturation stages and mean ages.

Midpalatal suture stage	N	Age (mean ± SD)
A	2	16 ± 2.83
B	28	13.11 ± 2.71
C	63	14.59 ± 2.61
D	6	15.5 ± 2.17
E	4	17 ± 0.82
Total	103	14.36 ± 2.7

Table 2 Spearman's correlation coefficients between midpalatal suture maturation and other developmental indices.

Developmental indices	N	Midpalatal suture maturation	p-value
CVM	47	0.244	0.098
Dental age	91	0.279**	0.007
Canine (L3)	91	0.245*	0.019
First premolar (L4)	91	0.242*	0.021
Second premolar (L5)	91	0.332**	0.001
Second molar (L7)	91	0.265*	0.011

* p < 0.05, ** p < 0.01

Discussion

Success of maxillary expansion depends on the status of the midpalatal suture (Melsen, 1975). Assessment of the midpalatal suture by using conventional occlusal radiograph was unreliable due to the overlapping of anatomical structures. CBCT had diagnostic advantages over conventional occlusal radiograph because its ability to visualize the midpalatal suture without overlapping of nearby structures (Liu et al., 2015). In present study, we used CBCT to evaluate the midpalatal suture and classified the midpalatal suture into 5 stages of maturation according to the method of Angelieri et al. (Angelieri et al., 2013). The results of this study indicated that the stage of midpalatal suture maturation increases with

an increase in the age of the subjects. However, the mean age for stage A was 16 ± 2.83 years, which was higher than the mean age for stage B, C, and D (Table 1).

CVM is widely used by orthodontists to evaluate skeletal maturity because of the simplicity, reproducibility, and no need for additional radiographs (Baccetti et al., 2005). Our study observed no significant correlation between midpalatal suture maturation stages and CVM. This result was consistent with Gorucu-Coskuner et al. (Gorucu-Coskuner et al., 2018). In contrast, Jang et al. (Jang et al., 2016) and Angelieri et al. (Angelieri et al., 2015) observed significant correlation between the midpalatal suture maturation and CVM. This inconsistency may be due to the small sample size of our study or the racial background of the studied subjects.

Several methods have been provided to determine dental age. Using time of eruption as a parameter has been reported to be more variable than the calcification stage (Nolla, 1952). In current study, we used calcification stages of the permanent mandibular teeth for determining dental age, and the maxillary teeth were not considered because superimposition of the anatomical structures in the maxilla such as the palate, the maxillary sinus, or the inferior border of the zygomatic arch. In the present study, there was a significant weak correlation between the midpalatal suture maturation stages and dental age. This finding was consistent with Jang et al. (Jang et al., 2016), who used Hellman's index for assessment of dental age and observed strong relationship between the midpalatal suture maturation and dental age. In addition, we also found that the development of the second mandibular premolar had the highest correlation coefficient and the first mandibular premolar had the lowest correlation coefficient with midpalatal suture maturation (Table 2).

The present study was the first study in Thai that evaluates the relationship between midpalatal suture maturation, CVM and dental age. The limitation of this study was the small sample size because we did not routinely perform CBCT imaging in every patient due to excessive dose of radiation exposure; thus only 103 subjects who met the inclusion criteria were selected. Future studies should include a larger sample size and investigate the association of the midpalatal suture maturation with other developmental indices that might be useful for diagnostic purpose.

Conclusions

The results of this study showed that the midpalatal suture maturation stage was not correlated with CVM. However, the maturation stage of the midpalatal suture showed significant weak correlation with dental age, and the mandibular second premolar showed highest correlation coefficient with the midpalatal suture maturation.

Acknowledgements

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