

Prediction Formula of Permanent Canine and Premolar Eruption in Mixed Dentition Patients at Universitas Airlangga, Dental Hospital Surabaya, Indonesia

Abstract

Background: The eruption of permanent canine, first and second premolars need to be predicted because they are erupted last, before the eruption of permanent first and second molars, in order to estimate the available space in orthodontic treatment. **Aim:** This study aimed to predict the eruption of permanent canine, first and second premolars in mixed dentition. **Materials and Methods:** A cross sectional clinical observation was conducted in 21 subjects of 13 males and 8 females with the age range of 8-12 years old. Their panoramic radiographs were used to create a prediction formula of permanent canine and premolars. The independent variables of this research are age, weight, height, birth weight, birth height, period of breastfeeding, and vertical distance of eruption. Data were analyzed by coefficient of multiple correlation followed by multiple linear regression analysis. **Results:** The prediction formula is as follows: $Y = -5107 + 1645 X_1 + 078 X_2$, where Y is the time of eruption, X_1 is the height, and X_2 is the vertical distance of eruption. **Conclusion:** The prediction formula is useful for serial extraction in orthodontic treatment. It is also useful for forensic odontology, especially in the determination or identification of ages. It is recommended to be implemented in the science of development, especially in orthodontics and forensic odontology.

Keywords: Forensic odontology, mixed dentition, orthodontic treatment, tooth eruption prediction

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Introduction

Tooth eruption is the process of tooth development initiated with the forming of tooth until the tooth is visible in the oral cavity and then reaches occlusion and contacts with the antagonist tooth. The permanent canine and premolars are the last teeth before the second and third molars erupt, so they often get less space. Canine teeth are very influential and contribute to the human facial esthetics because they support the vertical dimension of face. Permanent canines are never indicated for extraction in orthodontic cases that require space. A tooth is called visible in the oral cavity if the tooth has penetrated the gingiva and does not exceed 3 mm above the gingival level, measured from the edge of the teeth tip or from the incisal edge.^[1]

The beginning and ongoing orthodontic treatment often depends on permanent tooth eruption. Time of tooth eruption has great variance on each individual. Tooth eruption may be variable based on gender.

Each tooth element may differ from other teeth elements during eruption, although in the same individual. The same teeth, on one side and the other, can be different at the time of eruption.^[2] Tooth eruptions are also variable by race, genetics, gender, socioeconomic status, nutrition, and carious conditions. Implementation and evaluation of prediction accuracy requires several things such as statistical analysis, long period of time, and consistency of use so that accurate measurements and predictions will be obtained. Tooth eruption has a large time range so to make the dental treatment on time, the prediction of tooth eruption requires a small time range. Data from the World Health Organization show that malocclusion is the most important concern in dentistry, after caries and periodontal diseases.^[3]

Malocclusion is an irregularity/deviation of normal tooth position, both the upper and lower dental arch relationship in sagittal, vertical, and transverse.^[4] Malocclusions can be caused by several factors, including genetic factors, malnutrition, bad habits,

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excessive teeth, carious teeth, and premature loss of primary teeth. Malocclusions can also be caused by the incompatibility between the size of the teeth and the jaw, which is commonly seen in tooth transition period (between the age of 6 and 12 years). Dissociation between the size of the teeth and the jaw is caused by genetic and environmental factors so that overcoming this case is more appropriate to be done during the tooth transition period in early adolescence. Premature series extraction can lead to undesirable effects, such as shifting to the direction of diastema. Delayed and late in receiving orthodontic treatment makes the treatment more complicated. Currently, one of the dental care procedures that has an increasing role is orthodontic treatment. Orthodontics is a science in dentistry profession that is responsible for the study and supervision of the growth of tooth development and anatomical structures that are related from birth to adulthood, including preventive and corrective actions on tooth dislocation.^[5]

The prevalence of malocclusion in adolescents in Indonesia is still high, ranging from 90% in 1983 to 89% until 2006, while dental health behavior in adolescents, especially about malocclusion, is still not good enough, and dental health services have not been optimal. Malocclusion not only causes physical pain but also psychological and social development that causes overall disruption to the quality of life of adolescents. One of the treatments performed during the tooth transition period to overcome the severity of the malocclusion is the serial extraction, where the sequence of permanent eruption plays an important role. Series extraction is the treatment of the primary and permanent teeth at specific moment. The sequence of tooth extraction is as follows: The primary can, the fourth incisor which is expected to flatten itself, and then if the first premolar grows, the first primary molar is retracted. The permanent canines will grow, the first premolar is retracted, so that the permanent canine gets a space. Serial extraction can prevent malocclusion become more severe, and also when done on time, this treatment does not require orthodontic appliances if necessary requires only a short period of time.^[6] Currently, one of the dental care procedures that has an increasing role is orthodontic treatment. Orthodontics is a science in the dental profession responsible for the study and supervision of growth and development of dental and anatomical structures that are related from birth to adulthood, including preventive and corrective measures on tooth dislocation.^[5]

Several researchs has been focusing on predicting tooth eruption. The first prediction is based solely on statistical calculations of repeated observations such as those done by Finn and Akin.^[7] Tooth eruption has a large time range but the prediction of tooth eruption requires a small time range, so that serial extraction can be done on time. If this treatment done to early, it can cause the occurrence of undesirable thing such as tooth shifting to diastema area. Late orthodontic treatment cause the treatment becoming

more difficult. Teeth eruption was predicted using index eruption by measuring the vertical distance. Teeth eruption was also influenced by nutritional status. According to Khan, children with high nutritional and socioeconomic status had their teeth eruption earlier.^[8]

Tooth growth begins in the womb. Tooth formation begins at 7 weeks of age. Pregnancy is a specific physiological change and this change requires a quality diet and a healthy lifestyle. During pregnancy, the need for food and iron increases. The recommended limit for pregnant women is twice than that of nonpregnant women, although the need for energy and calories increases, but with smaller percentage of the need for vitamins. It is a known fact that a woman needs good food during pregnancy, but her food status is a critical time of conception. Female bodyweight at the time of conception can affect pregnancy and birth as well as infant's health. In a pregnant woman, weight is more important than appearances because underweight condition can increase the possibility of premature birth. Body mass index (BMI) is an index of a mother's weight status. Lean women with a BMI of <20 have an increased risk of delivering a low birth weight infant and there is a chance of premature birth. Overweight and obese women have an increased risk of some adverse pregnancy outcomes including premature birth. Obese women have an increased risk of high blood pressure, unbalanced blood sugar metabolism, gestational diabetes, preeclampsia (a condition with high blood pressure), fluid retention, protein in the urine, prolonged labor, unplanned sectio caesaria, and difficulty in getting started and continuing breastfeeding. Obesity can complicate pregnancy and birth and affect baby's health.^[9] Until now, there have been no predictions about the eruption of premolar and permanent canines in Indonesia, so it is necessary to make predictive models for Indonesians.

Materials and Methods

This study received an ethical clearance approval letter for animal subjects from the Ethics Research Committee of Faculty of Dental Medicine, Universitas Airlangga Surabaya, East Java, Indonesia. This research type was an observational descriptive study with clinical observation. The research design was cross sectional; the study population included all children in the late tooth transition period who came to Dental and Oral Hospital Faculty of Dental Medicine Universitas Airlangga, Surabaya, East Java, Indonesia. Criteria for sampling included age of tooth transition period and Deutero-Malay ethnic group. Sampling was done by interview and examination inside the oral cavity. A complete anamnesis and panoramic photographs were taken and height and weight were measured [Figure 1]. In this study, the exclusion criteria were growth abnormalities (dwarfism and gigantism), dental abnormalities (agenesis, mesiodens, and laterodens), and premature loss of primary teeth.

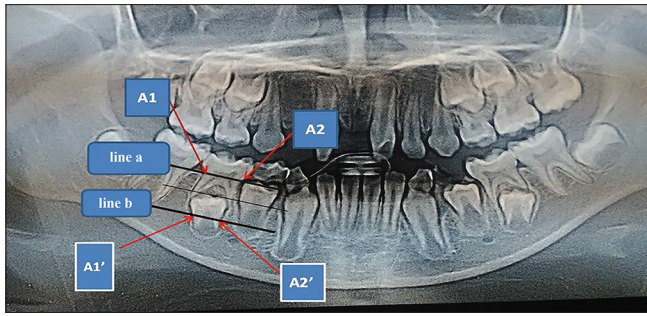


Figure 1: Panoramic image to predict permanent canine and first premolar

The study participants were interviewed after obtaining consent for the study. The study participants were questioned about the date of birth, and then the age at the time of taking panoramic photographs was calculated by using Excel program. Then, examination inside the mouth was done in order to fill out the research form. The recorded data included date of observation, date of birth, and further measurements of weight and height. Then, a panoramic shot was taken once at a private laboratory. Periodic observation was done. Observation was made every 2 weeks. When the teeth had penetrated the gingiva, the date was noted, and then its vertical distance was calculated. The points used for reference are shown in Figure 2.

Calculation examples for the canines are as follows:

Time required for eruption.

- Date of picture taken: January 10, 2010
- Date of eruption: October 20, 2010
- Time difference: 9.3 months.

Data were analyzed by calculating the coefficient of multiple correlation, followed by multiple linear regression analysis. The obtained regression line equation is as follows:

$$Y = K + ax_1 + bx_2 + cx_3 + dx_4 + ex_5 + fx_6 + gx_7$$

Where

where Y = Time taken for eruption

K = Constant.

$a, b, c, d, e, f,$ and g = a value (number)

X_1 = age

X_2 = weight

X_3 = height

X_4 = weight of birth

X_5 = height of birth

X_6 = period of ASI/breastfeeding

X_7 = vertical distance of eruption.

Furthermore, the resulting Y value indicates the length/time taken for eruption.

Results

The study participants were 21 patients who will receive removable orthodontic treatment at Orthodontic

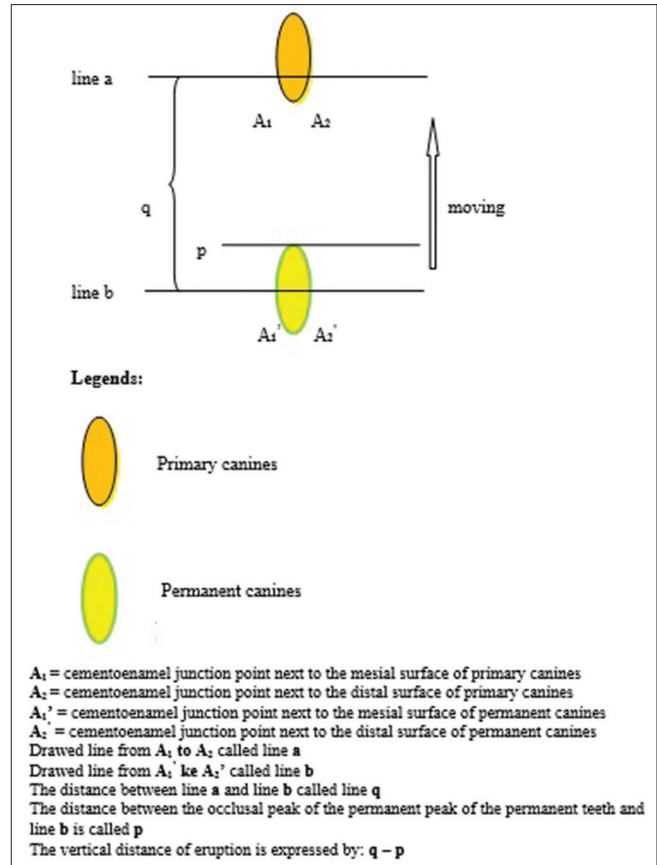


Figure 2: The points used for reference to determine vertical distance of eruption

Clinic, Dental and Oral Hospital, Airlangga University, in 2013–2015, with 13 men and 8 women between the ages of 8 and 12 years. Data obtained were age, weight, height, birth weight, birth height, period of breastfeeding, vertical distance, and length of eruption [Table 1].

A prediction formula was found to determine the time required for canine/premolar eruption. Linear regression analysis was used with backward method and the following results were obtained:

$$Y = -5,107 + 1,645 X_1 + 0,78 X_2$$

where Y = ln time taken for eruption

X_1 = ln height

X_2 = ln vertical distance of eruption.

Discussion

The usage of the cemento-enamel junction point as a measurement point in this study has also been appreciated by Garn, who used the cemento-enamel junction point to measure root lengths in local X-ray photographs.^[10]

A prediction formula was found to determine the time required for permanent canine and premolars eruption for mixed dentition Surabayan, the Indonesian patient at Universitas

Table 1: Description of observational result data

Variables	Mean±SD	Minimum value	Maximum value
Age (months)	123.94±6.96	112.1	138.7
Weight (g)	32571.43±8158.26	22000	46000
Height (cm)	132.19±8.65	110	144
Birth weight (g)	2997.62±134.67	2800	3200
Birth height (cm)	49±2.05	44	52
Period of breastfeeding (month)	13.76±9.72	0	28
Vertical distance of eruption (cm)	0.48±0.36	1.2	0.04
Length of eruption (month)	9.91±5.39	1.4	18.8

SD: Standard deviation

Airlangga Dental Hospital. This prediction formula could not be applied to permanent teeth that have blocked eruption path due to primary premature tooth loss, ectopic position teeth, ankylosis of primary teeth that about to be replaced, and misplaced teeth. The prediction formula could only be applied for normal circumstances. This prediction formula relates to the serial extraction treatment, which helps to determine the retraction time. Prediction of premolar and permanent canine eruption is required as a guide to determine the retraction time in the serial extraction treatment.^[11]

In orthodontics, it is crucial to understand the prediction of degree and size of the jaw growth, the tooth growth, and the tooth eruption in order to gain satisfying treatment results. The growth spurt and its association with craniofacial growth should also be understood.^[12] This prediction formula is also indispensable in primary dental care. In principle, all caries primary teeth should be resorbed by permanent tooth. It must be noted when the primary teeth will exfoliate.^[13]

Lylod argued that the retraction of premolars for leveling incisors and canines can be done if all permanent teeth grow (except for the third molar) and not to be done during transitional dentition (serial extraction).^[14] Meanwhile, the referring method requires longer maintenance and retention time; besides, it also requires a mechanism to move more teeth. The other advantages of serial extraction are to fix the malocclusion as early as possible, to prevent psychological disorders, and to prevent the occurrence of caries due to crowding teeth.^[15]

There are several methods for predicting tooth eruption such as predicting tooth eruption by comparing age to the average age when the teeth erupted and determining root development that requires specialized expertise and experience. The method used in this study is based on the results of vertical distance measurements. Therefore, the measurement is more objective when compared to the previous method.^[16]

The extraction of the first premolars was done when the permanent canine is about to erupt. If prematurely extracted, it will decrease the mastication function in long period due to the reduction number of teeth, whereas if late to be extracted, the canine will grow outside the dental

arch. The sequence and timing of permanent and premolar canine eruptions may affect the treatment plan; thus it can be concluded that the prediction of tooth eruption is needed to support the diagnosis, treatment plan, and treatment outcomes, so that expected treatment will be more efficient.^[13]

Premature loss of primary teeth may not necessarily speed up or slow down the eruption of replacement teeth. The usage of uncontrolled space maintainers can lead to inhibition of tooth eruptions. Indication of space maintainer's usage should also consider the growth of replacement teeth and thickness of bone alveolar covering the replacement teeth. X-ray image shows that the replacement of tooth enamel is not covered by alveolar bone anymore; the space maintainer does not need to be used. The X-ray images show that the replacement of teeth is still covered with thick bone alveolar, and it is necessary to install space maintainer. However, it still needs to be explained "How thick is the alveolar bone covering the teeth" Hence, it is expected that the obtained prediction formula could help to determine whether necessary or not to install a space maintainer.^[17]

Predictions of tooth eruption have also been carried by measuring the vertical distance in the local X-ray images between the peak of permanent teeth crown and the line formed between the two cemento-enamel points of the primary teeth that are about to be replaced. However, this method still has some disadvantages: consistency in making X-ray photographs due to differences in film position during taking the photograph. Therefore, another method is needed that could increase the accuracy of the eruption index. The prediction formula obtained in this study is expected to be useful also for age identification in forensic cases and screening for training candidates of soccer players.^[18,19]

Conclusion

The prediction formula is useful for serial extraction in orthodontic treatment. It is also useful for forensic odontology, especially in the determination or identification of ages. It is recommended to be implemented in the science of development, especially in the orthodontics and forensic odontology.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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