Estimation of the effect of physiological and pathological root resorption of primary teeth on the growth of permanent teeth in 6- to 8-year-old girls using panoramic radiographs

N A Wahono*, Z S Nissa and H Soenawan
Department of Pediatric Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta 10430, Indonesia
E-mail: niekaadhara@yahoo.com

Abstract. Primary teeth (healthy or slightly carious without pulp involvement) undergo physiological root resorption, whereas pathological root resorption occurs in primary teeth with severe caries and pulp involvement. Awareness of the dentist regarding the effect of root resorption in primary teeth on the stages of growth in permanent teeth will be useful during the treatment planning process. The aim of this study was to determine the effect of physiological and pathological primary root resorption on the stages of growth in permanent teeth among girls aged 6–8 years. A total of 30 panoramic radiographs of 72 mandibular primary molars were used in this descriptive cross-sectional study. A significant difference ($p < 0.05$) in the growth of permanent teeth was noted between primary teeth with physiological root resorption and those with pathological root resorption. The types of root resorption in primary teeth appear to affect the growth of their successors in the permanent dentition in girls aged 6–8 years.

1. Introduction
Root resorption of the primary tooth is a physiological response that occurs because of loss of mineralized tissue via osteoclastic cells when the permanent tooth erupts [1]. The process of resorption is mediated by the tooth follicle and stellate reticulum [2]. Physiological root resorption of the primary tooth occurs intermittently and begins at the root nearest to the permanent teeth [3].

Besides physiological resorption, pathological resorption may also occur in primary teeth with pulp involvement due to infection or necrosis. Caries with pulp involvement and pulp treatment are some of the most important factors that influence pathological resorption in primary teeth [4]. Inflammation and/or infection may spread from the caries-affected pulp to the periradicular tissues in the primary tooth, thereby affecting the underlying and surrounding tissues [5].

Bone destruction that occurs during pathological resorption leads to rapid root loss of the primary tooth resulting in premature tooth loss. As a result, the underlying permanent tooth may erupt prematurely before it is fully formed [5].

The tooth undergoes several stages of growth until eruption in the oral cavity. The development stages of the permanent tooth have been classified by several researchers, such as Schour and Massler, Moorrees,
Anderson, Gleiser and Hunt, Nolla, and Demirjian. The assessment of the growing stage of the tooth within the bone can be performed using a panoramic radiograph, which produces a picture of the primary teeth and the underlying permanent teeth in one film. In addition, it indicates the presence of root resorption in the primary tooth followed by the growth and development stages of the permanent tooth.

Some of the factors that affect the growth of teeth include genetic, hormonal, gender, systemic, and environmental factors. Nutrients and the presence of infection and/or inflammation due to caries with pulp involvement account for some of the environmental factors that can affect the growth of teeth.

The present study aimed to analyze the effect of root resorption of primary teeth on the growth of permanent teeth during the difference stages of permanent teeth growth, and to evaluate the differences in growth based on the type of resorption (physiological and pathological).

2. Methods
Digital panoramic radiographs of girls aged 6–8 years in the year 2010–2012 obtained from the Teaching Dental Hospital, Faculty of Dentistry, Universitas Indonesia were used in this descriptive cross-sectional study. The purposive sampling technique was used in this study from April–July 2013. In the present study, 30 panoramic radiographs were used with the aim to ascertain the presence or absence of differences in the growth of permanent teeth following physiological and pathological resorption of primary teeth. First, the samples were collected and classified on the basis of the age of the subjects. After that, the resorption rates and permanent growth were measured with the aid of a reference point on the teeth using Adobe Photoshop CS3 (America).

Data analysis was performed by using software SPSS Statistics 18.0. Chi-squared test was used to analyze the data. Fisher’s exact test was used as an alternative to chi-squared test if the frequency was less than 5, which is more than 20%. The level of confidence used was 95%, and the significance level was set at $p \leq 0.05$.

3. Results
A total of 30 panoramic radiographs obtained from girls aged 6 years ($n = 10; 33.33\%$), 7 years ($n = 9; 30\%$), and 8 years ($n = 11; 36.67\%$) were examined in this study. The effect of age on the growth of permanent teeth during dental stages D and E according to Demirjian’s classification is presented in Table 1.

| Age | D | E | n  | %  | P    |
|-----|---|---|----|----|------|
| 6 Years | 16 | 6 | 22 | 30.56 |      |
| 7 Years | 10 | 11 | 21 | 29.17 | 0.109 |
| 8 Years | 13 | 16 | 29 | 40.27 |      |
| Total   | 39 | 33 | 72 | 100  |      |

$n$, number of teeth

The results of the chi-squared test revealed no significant differences in the growth of the permanent teeth during stages D and E with regard to the age of the subjects ($p > 0.05$).

Next, we evaluated the effect of physiological and pathological root resorption on the growth of permanent teeth (Table 2).
The growth of the permanent teeth was found to be significantly associated (p < 0.05) with the types of root resorption (physiological or pathological). The association between rate of physiological root resorption and growth of permanent teeth during dental stages D and E according to Demirjian’s classification is presented in Table 3.

Table 3. Differences in the growth of permanent teeth during stages D and E according to Demirjian’s classification based on the level of physiological root resorption of primary teeth.

|            | D  | E  | N  | %  | P   |
|------------|----|----|----|----|-----|
| Cervical 1/3 | 0  | 2  | 2  | 4.76 |     |
| Middle 1/3  | 7  | 16 | 23 | 54.76 | 0.230 |
| Apical 1/3  | 9  | 8  | 17 | 40.48 |     |
| **Total**   | 16 | 26 | 42 | 100 |     |

N: number of teeth; p<0.05

No significant difference in the growth of permanent teeth was observed with regard to the amount of root resorption (p > 0.05).

Similarly, the association between rate of pathological root resorption and growth of permanent teeth during dental stages D and E according to Demirjian’s classification is presented in Table 4.

Table 4. Differences in the growth of permanent teeth during stages D and E according to Demirjian’s classification based on the level of pathological root resorption of primary teeth.

|            | D  | E  | N  | %  | P   |
|------------|----|----|----|----|-----|
| Cervical 1/3 | 5  | 2  | 7  | 23.33 |     |
| Middle 1/3  | 10 | 3  | 13 | 43.33 | 1,000 |
| Apical 1/3  | 8  | 2  | 10 | 33.33 |     |
| **Total**   | 23 | 7  | 30 | 100 |     |

N: number of teeth; p<0.05

The results of Fisher's exact test revealed no significant difference in the growth of permanent teeth with regard to the rates of pathological root resorption in the primary teeth (p > 0.05).
4. Discussion

This study was conducted using panoramic dental radiographs of girls within the age range of 6–8 years. The panoramic images are converted in digital form for ease of measurements during research. Moreover, digital radiographs are more practical and inexpensive to use, with the added advantage that data can be processed faster using these images.

Mandibular primary molar and premolar teeth were examined in this study because the rate of resorption and the growth stages of these teeth are easier to access in the radiographs. Moreover, dental and oral diseases, especially caries, are common in mandibular primary molars [6].

This study chose subjects aged 6–8 years because the growth of the premolars occurs during this age range; therefore, variations in growth stages can be observed during this period. According to the risks data, the prevalence of dental and oral diseases during the ages of 6–8 years is quite high, especially in girls [7]. In addition to the growth of the premolars, the first molar teeth are not exfoliated during this period, in most cases.

According to Demirjian’s classification, there are eight stages of tooth growth beginning from stage A to stage H, which evaluates the dental age based on the process of tooth formation from calcification of the tip of the cusp to closure of the root apex tip; the classification of each stage was based on the shape, size, and relative length of the root [8]. The original method of classification used only seven mandibular permanent teeth. On the basis of the interpretation of the dental radiographs of girls aged 6–8 years, premolars develop during stages D and E in Demirjian’s classification [9], wherein at D stage, crown formation is completed and at E stage the root is formed; however, the length of the root is less than the height of the crown at this stage.

In line with previous studies, no significant difference in the growth of permanent teeth was noted on the basis of the age of the subjects in the current study. In addition, several stages of growth were observed within the same age in this study [9].

The occurrence of physiological and pathological root resorption had no effect on the growth of permanent teeth in this study. This is in accordance with the findings of a previous study where pathological resorption as a result of infection and/or inflammation of the pulp in a primary tooth caused disruption of growth in the permanent tooth. Dental inflammation or periradicular infection may cause structural alterations in the permanent tooth [4]. The rate of permanent tooth growth is slower in cases where the primary tooth has undergone pathological root resorption when compared with cases where the tooth has undergone physiological root resorption. In the study by Pindborg, the permanent teeth presenting with delayed growth were found to be associated with infected and/or inflamed primary teeth [10].

The rate of root resorption was not significantly associated with the stage of growth of permanent teeth in this study. Resorption rates in primary teeth have been shown to cause changes in the rates of permanent teeth eruption rate, although the growth was not affected. Chronic inflammation occurring in the deciduous tooth that undergoes pathological resorption can cause bone destruction resulting in early tooth eruption [4]. On the other hand, delayed eruption can occur because of the formation of scar tissue, which forms a mechanical barrier that inhibits eruption. Alternatively, the permanent tooth can regulate the root resorption process in the primary tooth, wherein the part of the root closest to the permanent tooth tends to resorb faster [4]. The findings of the present study are in line with those reported previously, where no significant changes in the formation of the roots of permanent teeth were observed on the basis of differences in the rates of resorption in the primary teeth [11]. Further studies evaluating the effect of root resorption levels in primary teeth on the rate of eruption in permanent teeth are merited. In addition, biomolecular research studies should be performed to examine the changes in permanent tooth structure following pathological root resorption in primary teeth.
5. Conclusions
A significant difference in the growth of permanent teeth was noted between primary teeth with physiological root resorption and those with pathological resorption among girls aged 6–8 years. Caries in deciduous teeth should be treated immediately so that the growth of permanent teeth is not affected.

6. References
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