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Classification and sequelae of arrested eruption of primary molars

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Aim. The aim of this study was to classify early arrested eruption of primary molars and to analyse and explain the sequelae for the surrounding alveolar bone and the succeeding premolar.
Design. The position of the arrested primary molars in the mandible, the height of the local alveolar bone, and the morphology and location of the succeeding premolar were evaluated on radiographs from 29 children.
Results. Four groups of arrest from mild to severe with regards to infra-position were categorized (Groups I–IV). Mean ages at the time of referral decreased from Groups I (8 years, 10 months) to Group IV (5 years, 9 months).
Sequelae. (i) Reduction of alveolar bone height (Groups I–III); (ii) delayed maturity of the succeeding premolar (two-thirds of the cases); (iii) malformation of the succeeding premolar (mainly Groups III and IV); and (iv) ectopically located premolar occlusal to the retained molar (Group IV).
Conclusions. The deeper in the alveolar process a primary molar is retained, the earlier the disturbance in the eruption has occurred, and the greater is the risk of the permanent tooth germ being malformed and malpositioned. It is estimated that the earliest occurrences of arrested eruption of primary molars supposedly occur before the age of 3.

Introduction

In a study of 1059 Swedish children, the prevalence of ankylosis of primary molars was found to be 8.9%, occurring most frequently in the mandible[1]. Different studies have indicated that there is a familial occurrence of ankylosis. This suggests that a genetic disposition is important in relation to ankylosis of primary molars[1].

Infra-occlusion has been described from as early as 3 years[2–4], but is most often registered at the interval of 6–11 years[2,5,6]. Seemingly, the occurrence of primary teeth in infra-occlusion increases with the child's age. Infra-occlusion is usually caused by ankylosis[1,7].

Infra-occlusion occurs with equal frequency for boys and girls[2,5,6], and no difference is seen in the prevalence between the right and left side[2,8]. The level of infra-occlusion can be measured in either millimetres or degrees and classified accordingly[2,9]. Generally, the most severe cases of infra-occlusion are described in older children[9].

Previous studies have merely concluded that the depth of the infra-occlusion increases concurrently with age. No aetiological explanations have been presented so far.

Cases of arrested eruption of the primary molars where the succeeding premolar is located occlusal to the primary molar have not been included in any aetiological complex of primary molar arrest, but have been reported as single cases only[10–16].

With regards to pathogenesis, Kürol concluded that a local growth obstruction of the alveolar process is observed as well as a delay in tooth development when the 'affected' side is compared with the 'unaffected' side[7]. The ankylosed condition of the primary tooth disappears concurrently with the physiological resorption process, which is delayed,

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indicating that ankylosis is usually a transient phenomenon[7]. Subsequently, the tooth will re-erupt when the ankylosed part of the tooth has been resorbed[7,17].

The purposes of this study were: to describe arrested eruption of the second primary mandibular molars in cases where the succeeding premolars are present, and classify the cases according to severity of infra-position; to analyse the height of the alveolar bone in the region of the arrested molar in the different groups of severity; and to analyse the maturity and location of the succeeding premolar.

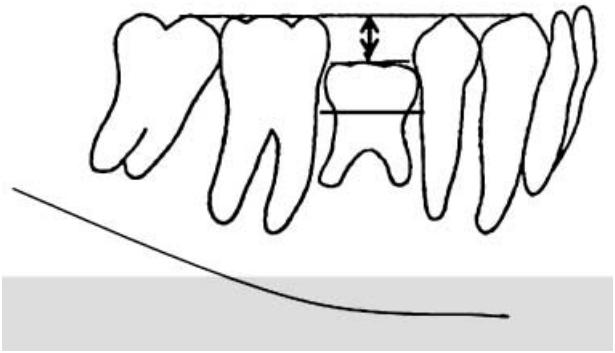

Fig. 1. The degree of arrest of the primary molar eruption was classified on panoramic radiographs according to the distance from the occlusal level of the primary molar to the occlusal level of the neighbouring teeth, illustrated by arrows.

Materials and methods

This study comprised radiographs from 29 cases. Nineteen cases came from the Department of Orthodontics, Copenhagen School of Dentistry, and 10 cases came from the Resource Center for Rare Oral Diseases, Rigshospitalet, Copenhagen.

The patients' ages at the time of the first available radiograph ranged from 4 years and 8 months to 11 years and 2 months. Panoramic radiographs were available in 28 cases. In one case, only dental radiographs were available.

Only cases in which the second primary mandibular molar was in infra-occlusion and where the enamel and dentin of the succeeding premolar were visible were included in this study.

Classification of primary molars in infra-occlusion

The degree of arrest of the primary molar eruption was classified according to the distance in millimetre from the occlusal level of the primary molar to the occlusal level of the neighbouring teeth (Fig. 1). The material was classified into groups.

Group I. Cases with a mild degree of infra-position were classified into Group I. In this group, the level of occlusion of the primary molar was equal to or less than half crown height of the actual primary molar when the occlusal level was compared with the occlusal surface of one or two fully erupted neighbouring teeth (Fig. 2a).

Group II. In cases belonging to Group II, the level of occlusion of the primary molar was half to full crown height below the level of the occlusal surface of one or two fully erupted neighbouring teeth (Fig. 2b).

Group III. Cases with a severe degree of arrest were classified into Group III. The level of occlusion of the second primary molar was equal to or more than full crown height below the level of the occlusal surface of one or two fully erupted neighbouring teeth (Fig. 3a).

Group IV. Cases with an extreme degree of arrested eruption were classified into Group IV. The second primary molar was found deeply subgingivally retained to such an extent that the occlusal surfaces of the fully erupted neighbouring teeth were located at a distance equal to or more than one and a half crown height of the primary molar compared with the level of the neighbouring teeth (Fig. 3b).

Schematic drawings of the four groups are shown in Fig. 4a.

The mandibular alveolar height

The height was measured in millimetre with a sliding calliper. The shortest distance from the upper level of the alveolar process to the mandibular base through the midpoint of the mesiodistal collum width of the primary mandibular molar expressed the local alveolar height

Fig. 2. (a) Panoramic radiograph from a boy, aged 10 years and 1 month, showing a mild degree of infra-position classified as a Group I case. In this group the level of occlusion of the primary molar is equal to or less than half crown height of the actual primary molar when the occlusal level is compared with the occlusal surface of one or two fully erupted neighbouring teeth. (b) Panoramic radiograph from a boy, aged 7 years and 9 months, showing a degree of infra-position classified as Group II, where the level of occlusion of the primary molar is from half to full crown height below the level of the occlusal surface of one or two fully erupted neighbouring teeth.

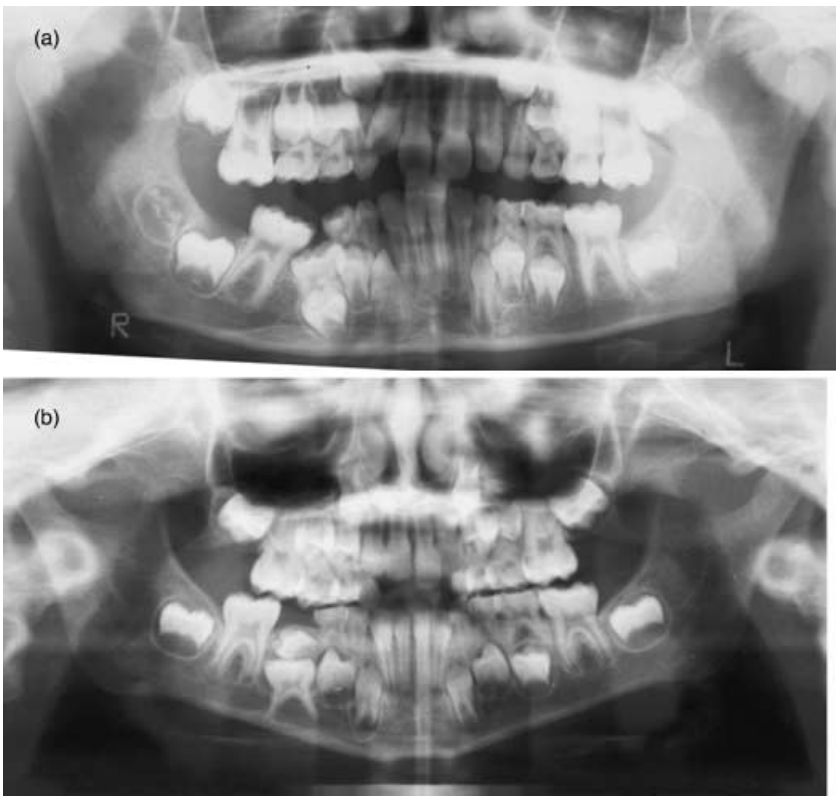

Fig. 3. (a) Panoramic radiograph from a girl, aged 8 years and 1 month, showing a severe degree of arrest classified as a Group III case characterized by a level of occlusion of the second primary molar equal to or more than full crown height below the level of the occlusal surface of one or two fully erupted neighbouring teeth. (b) Panoramic radiograph from a girl, aged 6 years and 2 months, showing an extreme degree of arrested eruption classified as a Group IV case. The second primary molar in Group IV is found deeply subgingivally retained to such an extent that the occlusal surfaces of the fully erupted neighbouring teeth are located at a distance equal to or more than one and a half crown height of the primary molar compared to the level of the neighbouring teeth. The permanent successor has a position occlusal to the primary molar.

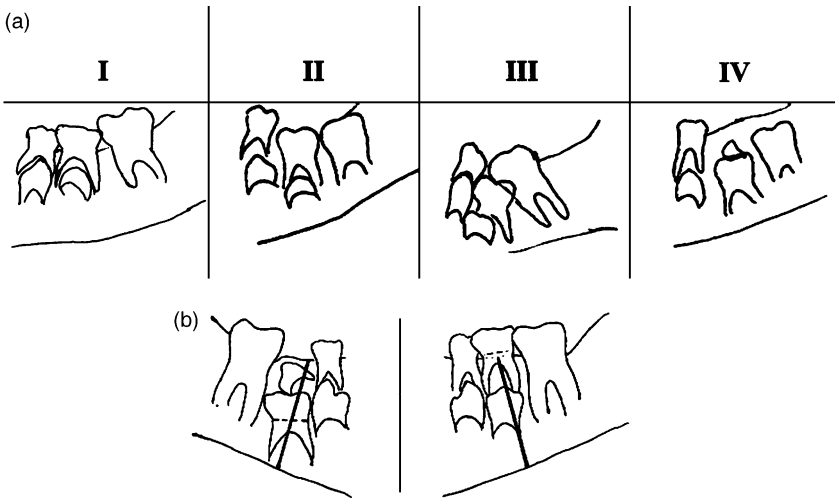

Fig. 4. (a) Schematic drawings of the four groups indicating the different severity of arrested eruption of the second primary molar in the right side of the mandible. (b) The alveolar height is defined as the shortest distance from the upper level of the alveolar process to the mandibular base through the midpoint of the mesiodistal collum width of the primary mandibular molar. The height is illustrated with vertical lines in a patient with arrested eruption of the left mandibular primary molar classified as a Group IV case (left) with a permanent tooth germ located occlusal to the retained primary molar. For comparison, the height in the unaffected left side of the same patient is illustrated to the right. In Group IV, the alveolar height is equal bilaterally.

(Fig. 4b). The height in the region of arrest was compared with the contralateral region (Fig. 4b).

The succeeding premolar

Stages of premolar development were evaluated according to Demirjian and Levesque[18]. In order to visualize smaller maturity differences than the ones defined by Demirjian and Levesque, stages between two stages were introduced. Finally, the tooth morphology and the position of the succeeding premolar were evaluated.

Results

The number of cases and the mean ages of the patients in each group are as follows:

Group I: Eight cases; mean age: 8 years and 10 months
Group II: Eight cases; mean age: 7 years and 2 months
Group III: Nine cases; mean age: 6 years and 8 months
Group IV: Four cases; mean age: 5 years and 9 months

The mean ages of the groups indicate that arrestment occurs earliest in Group IV and latest in Group I.

The mandibular alveolar height

Group I. The height of the alveolar bone in the affected region was 94% of the height registered in the unaffected contralateral region.

Group II. The height of the alveolar bone in the affected region was 81% of the height registered in the unaffected contralateral region.

Group III. The height of the alveolar bone in the affected region was 87% of the height registered in the unaffected contralateral region.

Group IV. The height of the alveolar bone in the affected region was equal to or higher than the height registered in the unaffected contralateral region.

Premolar maturity

In two-thirds of all cases, a retardation of dental maturation of the premolar ranging from 0.5 to 2 stages was observed in the affected region compared with the contralateral region. A delay in maturity was registered in all four groups. In each group, bilateral identical maturity stages were also observed (Fig. 5).

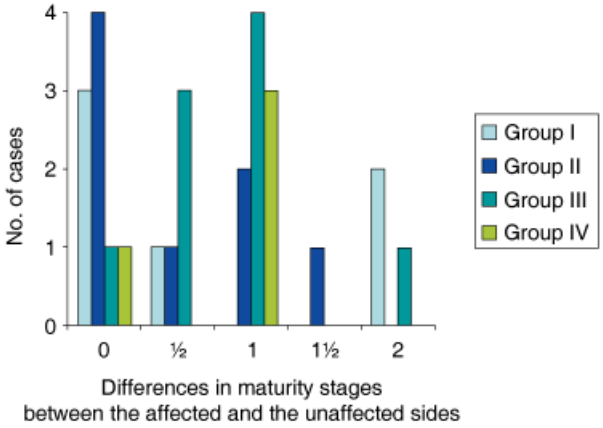

Fig. 5. This diagram shows the distribution of maturity differences between the affected and the unaffected sides. **0** indicates no difference in maturity of the succeeding premolar bilaterally. **1** and **2** indicate that there is a difference, evaluated as one and two maturity stages (18), in the maturity of the succeeding premolar between the affected and unaffected sides. $^{1}/_{2}$ indicates that there is a bilateral difference in the maturity stage less than one stage. $1^{1}/_{2}$ indicates a maturity stage less than two stages but more than one stage defined by Demirjian and Levesque[18]. The figure illustrates that within all four groups a later maturation of the premolar in the affected region occurred compared to the contralateral region. In each group bilateral concurrence of the maturity stages was also observed.

Premolar morphology

With regards to the morphology of the premolar, crown malformation was mainly registered in Groups III and IV. In Group IV the crowns of three of the four involved premolars were malformed. The malformations were diminutive crowns. Due to incomplete root development, the root morphology could not be registered (Fig. 6).

Location of premolars

The location of the premolar was ectopic in Groups III and IV, but normal in Groups I and II. In Group III, the premolar was tilted mesially or distally (Fig. 3a), and in Group IV the permanent successor was located occlusal to the deciduous molar in all cases (Figs 3b and 6).

Discussion

Previous studies have concluded that the depth of infra-occlusion increases concurrently with age[9]. The aetiology and the sequelae of this infra-occlusion have not been classified. Serious cases of arrested eruption (Group IV) with a succeeding premolar located occlusal to the primary tooth have not been included in any similar study but only described as case reports[10–12,14–16].

It has been concluded that in cases of arrested eruption (ankylosis) of primary molars, local growth retardation is seen of the alveolar process as well as an approximately 6 month's developmental delay in maturity of the permanent successor compared with the 'unaffected' side[7]. This is in accordance with the present study.

The inequality of the material may influence the measurements of the alveolar bone height but does not influence the overall categorization of the material.

The present study showed that it is possible to classify the material according to degree of arrested eruption. By correlating the groups of arrested eruption with the age of each individual, it is clear that individuals with the most severe degree of arrested eruption (Group IV) are also the youngest. The new observation

Fig. 6. Panoramic radiograph from a girl, aged 5 years and 4 months, showing an extreme degree of arrested eruption classified as a Group IV case. The permanent successor has a position occlusal to the primary molar. The permanent successor is malformed (diminutive) and located in a position occlusal to the primary molar.

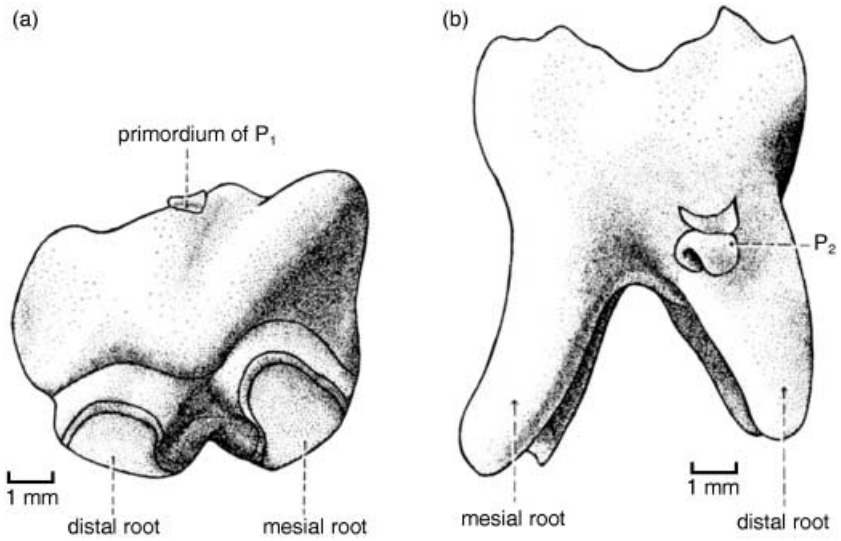

Fig. 7. (a) Reconstructed model of primary first mandibular molar indicating the position of its successor, the primordium of the first premolar (P_1) in an 11-month-old infant, lingual view. (b) Reconstructed model of primary second mandibular molar indicating the position of its successor, the primordium of the second premolar (P_2) in a 2-year-old child, lingual view. Reproduced from Ooe[21] (figs 10.7 and 10.8) with kind permission from Ishiyaku Publishers, Inc.

indicates that ankylosis occurred earliest in the cases in Group IV.

The present study does not describe the aetiology behind the arrest of eruption. However, recent studies have suggested that this may relate to local disturbances in the periodontal membrane of RANK-RANKL-OPG system[19,20].

With regards to the phenotypic appearance in Group IV, where the premolars are located occlusal to the primary molars, it is obvious to look for an explanation. Turning to early embryological development of the primary and permanent teeth as it occurs in the premolar region, an answer could be that the early developmental interrelation of the two tooth buds due to migration or guiding of the primary molar and the succeeding premolar does not occur. This developmental course during which the permanent tooth bud changes its position from the region around the occlusal surface of the primary molar to an interradicular position on the primary molar is beautifully illustrated in Ooe's figures reproduced in Fig. 7. The illustrations do not explain how and why the mutual relation between the two primordia changes. In the present cases (Group IV), it may be presumed that the abnormal position of the premolar is due to an early arrest in eruption of the primary primordium caused by ankylosis. It is estimated that this arrest in eruption supposedly occurs before the age of 3 when the permanent tooth bud in the initial stage is located laterally to the arrested primary molar. During development the permanent tooth germ will not migrate to an interradicular position below the non-erupting primary molar as under normal conditions. Instead it will erupt independently and obtain a position occlusal to the primary molar.

It was observed that the difference in the bilateral vertical osseous height of the alveolar process gradually increased from Group I to Group III, whereas the height of the 'affected' side in Group IV was actually observed to be slightly higher than in the 'unaffected' side; a phenomenon possibly related to bone induction from the permanent tooth germ in the non-affected side[22].

With regards to maturity, morphology, and position of the permanent successor, this study concludes that a delay in maturity was observed in the majority of cases within all four groups. An explanation for this phenomenon was not found.

Deviant morphology of the succeeding premolar was seen mainly in Groups III and IV. This suggests that in cases with early arrested eruption of the primary molar where the permanent tooth germ has not found its normal position, there is a significant risk of malformation of the permanent tooth crown, possibly due to limitation in space.

The position of the tooth germ of the second premolar appeared to be normal in Groups I and II. In Groups III and IV ectopic positions of the permanent tooth germ were registered in the horizontal plane, often with a tilting that may be connected with the growth pattern of the jaw.

In the present study, no suggestions to the treatment of retention of primary molars are provided, but it is clear that treatment options differ in the three groups and depend on the age of the patient, the local conditions in the affected region and the dentition in general.

In conclusion, this study has shown that the prognosis for the permanent successor depends on the time when the primary tooth becomes ankylosed. The deeper in the alveolar process a primary molar is retained, the earlier the disturbance in the eruption has occurred, and the greater is the risk of the permanent tooth germ being malformed.

Additionally, the more the position of the permanent successor deviates from normal, the more likely it is that retention occurred at an early stage.

What this paper adds

- It is estimated that arrested eruption of a primary molar can occur before the age of 3.
- The earlier arrest of primary molars appears, the more serious are the sequelae for the surrounding alveolar bone and the succeeding premolar. The sequelae are reduction in alveolar bone height and for the succeeding premolar malformation, late dental maturity, and malposition.
- The succeeding premolar is located occlusal to the arrested primary molar in cases with arrest in early childhood.

Why this paper is important to paediatric dentists

- Early classification of arrested eruption is important for the correct treatment.
- The occurrence of a premolar located occlusal to the primary molar has gained a plausible explanation providing dentists with an understanding of a condition that has been unexplained so far.

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