Original Article

Prevalence of Ectopic Eruption, Impaction, Retention and Agenesis of the Permanent Second Molar

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ABSTRACT

Objective: To elucidate the prevalence of ectopic eruption, impaction, and primary and secondary retention as well as agenesis of the permanent second molar (M2) among adolescents.

Materials and Methods: After a sample size calculation, dental records, including radiographs, of 1543 patients (722 girls and 821 boys), from three clinics in the city of Malmoe, Sweden, were retrospectively analyzed. Series of annual records and radiographs were examined for all patients from 10 to 16 years of age and were carried out during 2004–2006. The prevalence of ectopic eruption, impaction, and primary and secondary retention as well as agenesis of M2s was registered in a standardized manner and according to preset definitions. In addition, the times of emergence of the M2s were recorded.

Results: The prevalence of ectopic eruption of M2 was 1.5%, the prevalence of primary retention was 0.6%, and the prevalence of impaction was 0.2%. This means that the overall prevalence of eruption disturbances was 2.3%. In addition, the prevalence of agenesis was 0.8%. The prevalence of ectopic eruption was significantly higher in the mandible. Those patients with eruption disturbances and agenesis of M2 showed significantly delayed eruption of their other M2s compared to the individuals without any eruption disturbances.

Conclusions: The prevalence of eruption disturbances was higher than reported earlier, and, even if the disturbances do not occur frequently, it is important to develop an early diagnosis in order to start the treatment at the optimal time.

KEY WORDS: Prevalence; Ectopic eruption; Impaction; Retention; Agenesis; Second permanent molar

INTRODUCTION

Tooth eruption is defined as the axial or occlusal movement of a tooth from its developmental position within the jaw towards its functional position at the occlusal plane.[1] Throughout life, tooth eruption continues to compensate for occlusal wear and growth of the jaws. Compensatory changes in the path of eruption also occur during the growth and development of the face. When this compensation is insufficient, positional anomalies and malocclusions may occur.[2]

Disturbances of eruption may depend on systemic or local factors. Systemic factors are present in patients with certain syndromes, and, as a consequence, usually multiple teeth are affected.[3,4] In patients with a local eruption disturbance, one or a few teeth are affected. It has been claimed that early diagnosis of eruption disturbances is important in order to start treatment at the optimal time and to minimize complications.[5–7]

First and second molars are of great importance for the normal development of the dentition and coordination of the facial growth.[8] The eruption of permanent molars differs from that of other permanent teeth because permanent molars do not have preceding primary teeth. Instead, the tooth germ of a permanent molar develops from the backward extension of the dental lamina.[1]

Few data are available in the literature concerning eruption disturbances or agenesis of the permanent second molar (M2). Predominantly, earlier studies have focused only on the prevalence of disturbed eruption of the lower second molar. The prevalence of

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retention/impaction of the lower permanent second molar has been reported as between 0.06 and 0.3%,[9–11] whereas Baccetti[12] found a prevalence rate of 1.7% failure of eruption of both first and second molars. Additionally, Evans[13] showed in a selected sample (patients referred for orthodontic treatment) an increase in the prevalence of impacted/retained lower second molar between the years 1976 and 1986.

Because a complete picture or answer to the prevalence of eruption disturbances or agenesis of the permanent second molar is not given in the literature, the purpose of this study was to elucidate the prevalence of ectopic eruption, impaction, and primary and secondary retention as well as agenesis of M2 among adolescents.

MATERIALS AND METHODS

Dental records including radiographs of an unselected sample of 1543 patients (722 girls and 821 boys, born between 1984 and 1989) from three Public Dental Service clinics in the city of Malmoe, Sweden, were retrospectively analyzed.

For all patients in the sample, the annual records and bitewing radiographs, in many instances supplemented by panoramic and periapical radiographs from 10 to 16 years of age, were examined during 2004–2006. The prevalence of ectopic eruption, impaction, and primary and secondary retention as well as agenesis of M2s was documented. Furthermore, in the series of annual radiographs, the times of eruption of M2s were registered. The radiographs were evaluated concerning the location of the teeth affected and the eruption pattern, and similar teeth in the contralateral side and opposite jaw were analyzed. The registration of the radiographs was carried out by one examiner in a standardized manner under good lighting conditions. In a second step, all radiographs with eruption disturbances and agenesis were reexamined by another examiner, and if interexaminer conflicts existed, these were resolved by discussion of each radiograph to reach consensus.

Definitions of Eruption Disturbances

Ectopic eruption: A disturbance in the eruption path that means that the M2 comes into contact apical to the prominence on the distal surface of the first permanent molar and the M2 will be locked[14] (Figure 1).

Impaction: Cessation of the eruption of a tooth caused by a clinically or radiographically detectable physical barrier in the path of eruption, or because of an abnormal position of the tooth[6] (Figure 2).

Primary retention: Cessation of eruption of a normally placed and normally developed tooth before gingival emergence without a recognizable physical barrier in the eruption path[6] (Figure 3).

Secondary retention: Cessation of eruption of a tooth after emergence without a physical barrier or ectopic position of the tooth.[6]

Agenesis: Congenitally missed tooth (Figure 4).

Normal emergence for M2 was defined according to Helm and Seidler[15] as in the maxilla 12.4 and 11.9 years for boys and girls respectively, and in the mandible 11.9 and 11.4 years for boys and girls, respectively. A tooth that was not erupted at the age of 15 years, but could be registered to erupt later in the radiographs was categorized as a late-erupted tooth (Figure 5).

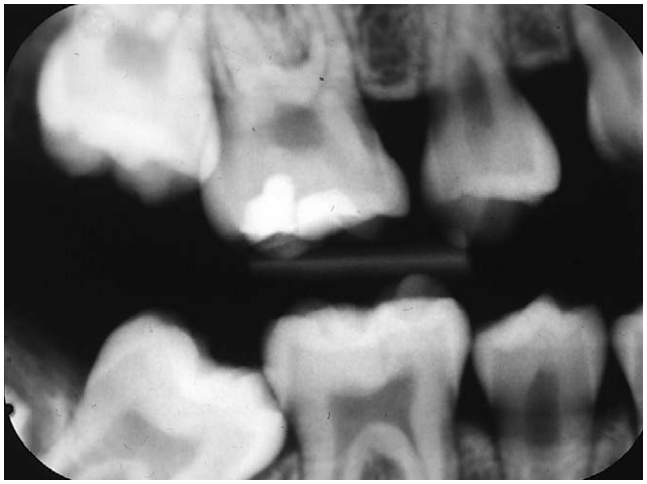

Figure 1. Ectopic eruption of the mandibular right permanent second molar.

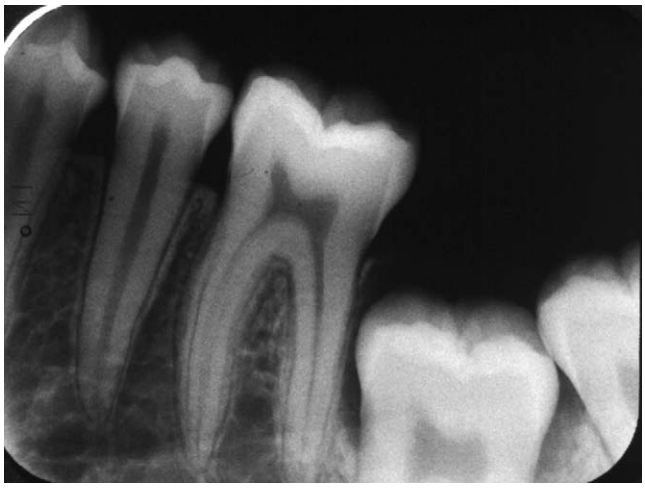

Figure 2. The lower left permanent second molar is impacted and the third permanent molar constitutes the physical barrier in the path of eruption of the second molar.

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Figure 3. The maxillary left permanent second molar in primary retention. No recognizable physical barrier in the eruption path could be found.

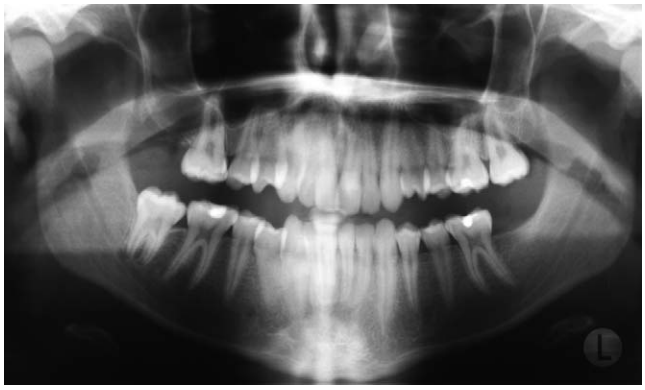

Figure 4. Agenesis of maxillary right and mandibular left permanent second molars.

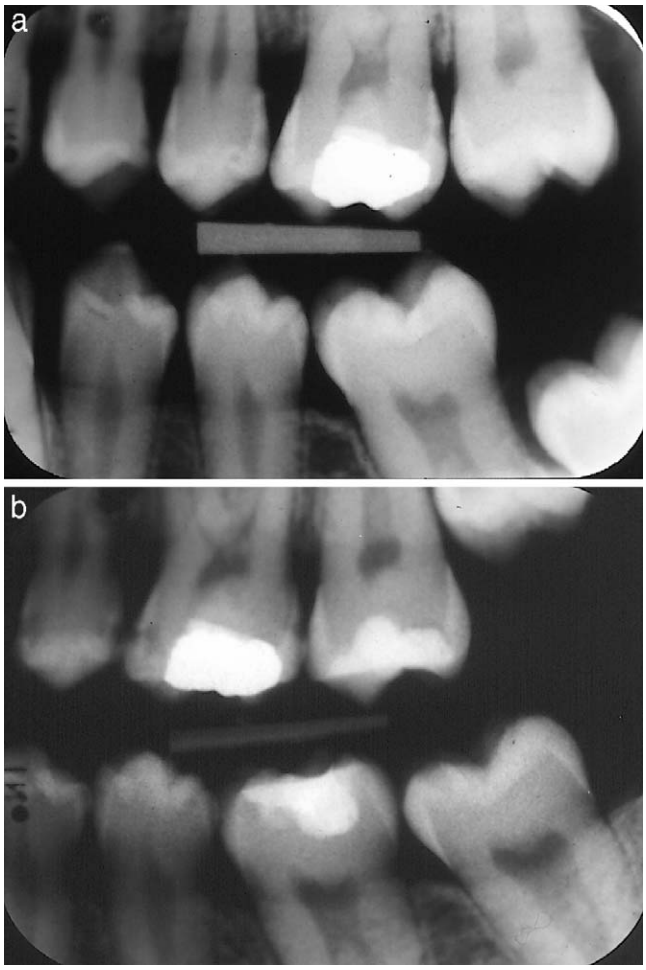

Figure 5. (a) Late eruption of the mandibular left second permanent molar in a 15-year-old boy. (b) Three years later, the second permanent molar has erupted.

Statistical Methods

A sample size calculation was performed, and, based on a sample of 1400 individuals and a proportion of 1% of positive findings with an alpha value of .05, a power of .878 was obtained. The chi-squared test or Fisher's exact test was performed to determine the statistical significance of differences in prevalence of findings between the sexes, between upper and lower jaws, and between the right and left sides of the patient. Means and standard deviations were calculated for the eruption time and a *t*-test was used to calculate differences between groups. Differences with probabilities of less than 5% ($P < .05$) were considered statistically significant.

RESULTS

The overall prevalence of eruption disturbances of M2 was 2.3%, and the prevalence of agenesis was 0.8%.

Ectopic Eruption

Ectopic eruption of M2 was found in 23 patients (1.5%). The 23 patients, 14 girls and 9 boys, together had 26 ectopically erupted M2s, which means that 20 patients had one ectopic tooth whereas three patients had two ectopic erupted M2s. Two of the M2s were detected in the maxilla and 24 in the mandible. The difference between jaws was significant ($P = .000$). No difference between the sexes ($P = .109$) or between the left and right sides ($P = .608$) was evident.

Impaction

The prevalence of impacted M2s was 0.2%. Three patients, two girls and one boy, each had one M2 impacted.

Primary Retention

Primary retention was found in 9 patients (0.6%). Three girls and six boys showed one M2 each in pri-

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Table 1. Emergence of the Second Permanent Molar in This Study[a]

	Disturbance Group			Normal Group		
	n	Mean, y	SD	n	Mean, y	SD
Maxilla						
Boys	24	14.0	1.4	697	12.7	1.2
Girls	23	13.5	1.3	602	12.3	1.1
Mandible						
Boys	24	13.7	1.4	697	12.0	1.2
Girls	23	13.4	1.6	602	11.5	1.1

[a] Number of individuals and time of eruption for teeth not affected by eruption disturbances in individuals with eruption disturbances, including those with agenesis (disturbance group), and in individuals without eruption disturbances (normal group). $P < .001$ for all differences between disturbance group and normal group.

mary retention. Seven M2s were found in the upper and two in the lower jaw ($P = .204$). No significant difference could be observed between the sexes ($P = .502$) or between the left and right sides of the mouth ($P = .071$).

Secondary Retention

No patient with secondary retention was found in this study material.

Agenesis

In 12 patients, four girls and eight boys, agenesis of one or more M2 s was found for a prevalence of 0.8%. A total of 23 teeth were missing, eight teeth in the upper jaw and 15 in the lower. Six patients had agenesis of one tooth, three of two teeth, and three patients of three or four M2s. No significant differences were found between sexes ($P = .404$), sides ($P = .763$), or jaws ($P = .132$).

Late Eruption

Late eruption was found in 48 patients (3.1%). There were 22 girls and 26 boys who had 76 M2s in late eruption. Twenty-two patients had one M2 delayed whereas 26 had delayed eruption of two or more M2s. Fifty-seven M2s were found in the upper and 19 in the lower jaw ($P = .000$). No significant difference could be observed between sexes ($P = .717$) or between the left and right sides of the mouth ($P = .251$).

Time of Emergence

Because of missed radiographs in 197 patients (97 girls and 100 boys) a complete series of annual radiographs between 10 and 16 years of age was not provided. Thus, the time of eruption could be documented in 1346 (87%) of the total sample. Table 1 presents the emergence times of M2s in the subjects with eruption disturbances, including those with agenesis, as well as in the individuals (control sample) without any eruption disturbances or agenesis. The patients with eruption disturbances and agenesis showed significantly delayed eruption of their other erupted M2s compared to the individuals without any eruption disturbances (Table 1).

DISCUSSION

The most important findings of this study were that the prevalence of ectopic eruption of M2s was 1.5%, the prevalence of primary retention was 0.6%, and the prevalence of impaction was 0.2%. This means that the overall prevalence of eruption disturbances was 2.3%, and in addition, the prevalence of agenesis was 0.8%. Moreover, the patients with eruption disturbances, including those with agenesis of M2, showed significantly delayed eruption of their other erupted M2s compared to the individuals without any eruption disturbances.

In this study the prevalence of eruption disturbances was found to be higher than that reported in previous studies.[9–13] This may be because of the fact that previous studies have focused exclusively on the prevalence of disturbed eruption of M2 in the lower jaw. Another reason may be that only an unerupted M2 or retention/impaction of M2 have been considered as eruption disturbances, rather than the whole spectrum of eruption disturbances as in this study.

Even if eruption disturbances of M2 do not occur frequently, early diagnosis is important. The diagnosis involves clinical and radiographic examination, and the clinical and radiographic characteristics are usually sufficient to differentiate between ectopic eruption, impaction, and primary and secondary retention.[6,10,11,13] Additionally, it is mandatory to place the treatment planning into the perspective of the stage of eruption in order to start the treatment at the optimal time, and thereby minimize complications.

Orthodontics is a major modality in treatment of impacted, ectopic erupted, and primarily retained M2, because these molars mostly have an unchanged periodontal ligament (PDL).[6] On the other hand, the major concern of secondary retained molars (not found in this study) is that these can not be moved orthodontically because of areas of ankylosis in the PDL or obliteration of the PDL.[6] Clinically, ankylosed molars have a metallic percussion sound in one-third of the subjects, but infraocclusion is the most reliable sign of secondary retention.[6,14,16] The explanation for the absence of any M2 with secondary retention is unclear. A conceivable explanation may be that in this study the patients were relatively young and the infraocclusion of M2 was not pronounced, so it was not yet possible to clinically or radiographically diagnose.

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Another important finding was that patients with eruption disturbances or agenesis of M2 showed significantly delayed eruption of their other undisturbed M2s. It has been suggested that anomalies in the position of teeth or a disturbed eruption path are of hereditary origin.[17,18] With a genetic background and the association between certain tooth and developmental anomalies, it may consequently be expected that a sample of individuals with a high prevalence of one anomaly will show an increased prevalence of other associated anomalies compared to the prevalence found in a general population.

An association between ectopic erupted maxillary first molars and ectopic maxillary canines has been described in the literature. In addition, the ectopic eruption of maxillary canines occurs at a higher than normal frequency in children with infraocclusion of primary molars and agenesis of premolars.[12,19,20] Moreover, it has been reported that a group of patients with arrested eruption of the lower M2, compared with a reference group, had an increased sagittal jaw relationship (Class II).[7] These patients also had a more frequent occurrence of morphological tooth anomalies, such as root deflections, invaginations, and taurodontism.[7] Additionally, Evans[13] reported that cases with impacted lower M2s had significant more crowding of the lower arch compared to the control group. Thus, it is not surprising that individuals with eruption disturbances also show delayed eruption of their other unaffected teeth.

It can also be pointed out that in those patients without eruption disturbances (normal group) the emergence time of M2 found was in concordance with earlier reported data.[15] However, the clinician must be aware that late eruption can occur. In this study, the prevalence of late eruption was 3.1%, and normally, the recommendation to the clinician is to wait for spontaneous eruption.

No sex differences were present concerning the prevalence of eruption disturbances; this is contrary to the findings of Varpio and Wellfelt,[11] who found that boys had more eruption disturbances of the lower M2 than girls. On the other hand, Baccetti[12] did not found any sex differences in the failure of eruption of the first permanent molar or M2. Thus, no clear picture can be found as to whether any correlation exists between sex and eruption disturbances of M2.

In the future, additional studies are desired in order to more clearly illustrate causal factors and the longitudinal effects on occlusal development caused by eruption disturbances of M2. Also, the optimal treatment times and treatment methods for specific eruption disturbances have to be further evaluated. Moreover, a question can be raised as to whether the prevalence of eruption disturbances of M2 might be increased by orthodontic treatments. However, this study was not intended to answer this question, and according to the dental records and radiographs, none of the patients were undergoing any orthodontic treatment at the time when the eruption disturbance was detected.

CONCLUSIONS

- The prevalence of eruption disturbances was somewhat higher than reported earlier, and even if the disturbances do not occur frequently, it is important to make an early diagnosis in order to start treatment at the optimal time.
- The patients with eruption disturbances and agenesis of M2 showed delayed eruption of their other erupted M2s compared to the individuals (normal sample) without any eruption disturbances.

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