

Dental anomalies in the primary dentition and their repetition in the permanent dentition: a diagnostic performance study

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Abstract This study investigated the recurrence in the permanent dentition of dental anomalies of the primary dentition. A sample of 189 subjects (100 males, 89 females, mean age of 5 years and 7 months) with anomalies of primary teeth (tooth hypodontia, supernumerary teeth, geminated teeth, and fused teeth) was selected and re-analyzed at a mean age of 11 years and 2 months for the recurrence of the dental anomalies in the permanent dentition. As a control group, 271 subjects (123 males, 148 females) without dental anomalies in the primary dentition were selected. The recurrence in the permanent dentition of the dental anomalies in the primary dentition was evaluated by measures of diagnostic performance. The results showed high values for the repetition of hypodontia (positive likelihood ratio = 102.0); low score for the repetition of hyperdontia (positive likelihood ratio = 6.5); low positive likelihood ratio (9.1) for gemination of primary teeth resulting in supernumerary permanent teeth; high positive likelihood ratio (47.0) for fusion of primary teeth followed by missing permanent teeth. Dental anomalies in the primary dentition are associated with an increased likelihood of anomalies of the succedaneous permanent.

Keywords Dental anomalies · Diagnostic performance test · Primary dentition · Permanent dentition

Introduction

Dental anomalies are less common in the primary dentition than in the permanent dentition [1], and they consist of hyperdontia, hypodontia, and double teeth. Hyperdontia is the presence of one or more supernumerary teeth with a prevalence rate in the primary dentition varying from 0.3 to 1.7% [2–5]. Lateral incisors are most commonly involved [6], whereas the duplication of canines is a very rare occurrence [3]. Hypodontia is the lack of one or more teeth with a prevalence rate in the permanent dentition ranging from 0.4 to 0.9% in European populations [3–5, 7–9], while it is more diffuse in Japanese children (2.4%) [10]. The prevalence rate of hypodontia of the primary teeth is smaller, and it approximates 0.3–0.8% [3, 11]. Double teeth is a term that describes both gemination of one tooth, which is the partial division of a single dental germ [12, 13], and fusion of two teeth, which is the partial union of two different dental germs [13, 14]. The prevalence rate for double teeth in the primary dentition varies from 0.5 to 1.6% [5, 9], while it has been reported to be 0.3% in the permanent dentition [15, 16]. Double teeth were reported to be 75% of the cases of dental anomalies in the primary dentition, with 94% of fusions and 6% of geminations [17]. Fusion in the primary dentition was reported to have a prevalence rate ranging between 0.14 and 3% [18].

Several previous reports in the literature suggest that the presence of a dental anomaly in the primary dentition may represent a risk factor for the recurrence of the anomaly in the permanent dentition [6, 17, 19]. However, the prevalence rate of the recurrence as well as the type of dental anomaly in the permanent dentition may vary. Whittington and Durward [6] analyzed a sample of 23 children with anomalies of the primary teeth, and they found that 14 subjects (60.9%) also had anomalies of the succedaneous

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permanent teeth. In a sample of 65 Malaysian subjects, Nik-Hussein and Abdul Majid [17] reported 100% of replication for hypodontia, 59% for double teeth, and 50% for hyperdontia. Almost identical prevalence rates were reported for hypodontia and double teeth in a sample of 48 Croatian children [19], while the 85.7% of the subjects with hyperdontia in the primary dentition showed the same anomaly in the permanent teeth. No previous study has assessed the prevalence of dental anomalies in the permanent dentitions of a control group of subjects who did not present with dental anomalies in their primary.

The aim of this study was to investigate the recurrence in the permanent dentition of dental anomalies of the primary dentition (hypodontia, hyperdontia, fusions, geminations) by means of diagnostic performance tests with the inclusion of a control group in a large white Caucasian population, to provide an estimation of how much the presence of a dental anomaly in the primary dentition changes the odds of having anomalies even in the permanent dentition.

Materials and methods

The study was undertaken on a parent sample of 8,200 patients from the files of the Department of Orthodontics, University of Florence. Dental casts, intraoral photographs and radiographic material of all subjects were examined. None of the subjects had received any orthodontic treatment or presented with systemic syndromes or diseases. The search found a sample of 189 subjects (100 males, 89 females) affected by dental anomalies in the primary dentition. The mean age was 5 years and 7 months \pm 13 months. The following types of dental anomalies were assessed on both dental casts and panoramic radiographs: hypodontia, hyperdontia, geminated teeth, and fused teeth. Differential diagnosis was performed on the basis of the number of teeth that were present, as well as on panoramic radiographs [12, 19].

All subjects were re-examined at a mean age of 11 years and 2 months \pm 14 months. Dental casts, intraoral photographs and radiographic material of all subjects were available at this time point, when the recurrence of the dental anomalies in the permanent dentition was recorded. It should be noted that geminated teeth in the primary dentition were tested for the presence of supernumerary teeth in the permanent dentition, while fused teeth in the primary dentition were tested for the presence of hypodontia in permanent dentition.

As a control group, 271 subjects (123 males, 148 females) without dental anomalies in the primary dentition were selected randomly from the files of the Department of Orthodontics, University of Florence. The presence of

dental anomalies in the permanent dentition affecting succedaneous teeth was assessed. The mean age was 5 years and 2 months \pm 9 months for the observation in the primary dentition, and 11 years and 5 months \pm 13 months for the observation in the permanent dentition.

Reproducibility of the diagnosis was assessed with the same operator (AM) re-examining the records of 200 patients 2 months after the first examination. Reproducibility was 100% for all dental anomalies.

Statistical analysis

The recurrence in the permanent dentition of the dental anomalies in the primary dentition was evaluated by means of measures of diagnostic performance [20]. Bayesian statistics (sensitivity, specificity, positive predictive value, and positive likelihood ratio) tested the performance of the variable “*presence of the anomaly in the primary dentition*” in the diagnosis of the following variable (effect to be diagnosed, or condition): “*presence of the anomaly in the permanent dentition*”. In particular, the likelihood ratio took into account both the sensitivity and specificity, and it provided a direct estimate of how much the test result changed the odds of having the diagnosed effect [20]. In this regard, it should be noted that a likelihood ratio greater than 1 indicates that the test result is associated with the presence of the condition, while a result of 1 means absence of any diagnostic performance. The further likelihood ratios are from 1, the stronger the evidence for the presence or absence of the condition. Likelihood ratios above 10 are considered to provide strong evidence to rule in diagnosis in most circumstances [21].

All computations were performed at StatPages website (<http://statpages.org/ctab2x2.html>).

Results

Number of teeth affected or not affected by the examined dental anomalies in the primary or permanent dentitions are reported in Tables 1, 2, 3, and 4. The diagnostic tests with the corresponding 95% confidence intervals are reported in Table 5.

Diagnostic tests revealed high values for the repetition in the permanent dentition of hypodontia in the primary dentition (positive likelihood ratio = 102.0) (Table 5). Hypodontia in the primary dentition was present in 45 subjects (32 females and 12 males). The repetition in the permanent dentition was 95.6%. One single primary tooth was missing in 26 subjects, while 19 subjects (4 males, 15 females) presented with the absence of two primary teeth (total 64 teeth). The anomaly affected the upper central

Table 1 Presence of hypodontia in the deciduous and the permanent dentition in the observed sample and in the control group (numbers refer to teeth)

	Hypodontia in permanent dentition	No hypodontia in permanent dentition	Total
Hypodontia in deciduous dentition	43	2	45
No hypodontia in deciduous dentition	12	259	271
Total	55	261	316

Table 2 Presence of hyperdontia in the deciduous and the permanent dentition in the observed sample and in the control group (numbers refer to teeth)

	Hyperdontia in permanent dentition	No hyperdontia in permanent dentition	Total
Hyperdontia in deciduous dentition	54	35	89
No hyperdontia in deciduous dentition	15	256	271
Total	69	291	360

Table 3 Presence of gemination in the deciduous dentition and hyperdontia in the permanent dentition in the observed sample and in the control group (numbers refer to teeth)

	Hyperdontia in permanent dentition	No hyperdontia in permanent dentition	Total
Gemination in deciduous dentition	9	11	20
No gemination in deciduous dentition	15	256	271
Total	24	267	291

Table 4 Presence of fusion in the deciduous dentition and hypodontia in the permanent dentition in the observed sample and in the control group (numbers refer to teeth)

	Hypodontia in permanent dentition	No hypodontia in permanent dentition	Total
Fusion in deciduous dentition	30	4	34
No fusion in deciduous dentition	12	259	271
Total	42	263	305

Table 5 Diagnostic performance of the analyzed anomalies in the deciduous dentition in predicting dental anomalies in the permanent dentition

Diagnostic tests	Variable diagnosed			
	Hypodontia Value (95% CI)	Hyperdontia Value (95% CI)	Fusion Value (95% CI)	Gemination Value (95% CI)
Sensitivity	78.2% (71.3–80.8)	78.3% (69.1–85.5)	71.4% (61.7–76.9)	37.5% (22.8–52.3)
Specificity	99.2% (97.8–99.8)	88.0% (85.8–89.7)	98.5% (96.9–99.4)	95.9% (94.6–97.2)
Positive predictive value	95.6% (87.1–98.7)	60.7% (53.6–66.3)	88.2% (76.2–95.0)	45.0% (27.4–62.7)
Positive likelihood ratio	102.0 (32.0–370.3)	6.5 (4.9–8.3)	47.0 (20.0–119.0)	9.1 (4.2–18.7)

incisor in 3 cases, the upper lateral incisors in 33 cases, the lower lateral incisors in 17 cases, the central incisors in 9 cases, and the upper primary canine and the lower first primary molar in 1 case each. When 2 teeth were missing, in 10 cases they were both upper lateral incisors, in 2 cases there was the simultaneous absence of one upper lateral incisor and one lower lateral incisor, 3 cases presented with the absence of both lower central incisors, and 4 cases with the absence of both lower lateral incisors.

The group of subjects affected by hyperdontia in the primary dentition presented with low diagnostic scores for the presence of the same anomaly in the permanent dentition (positive likelihood ratio = 6.5) (Tables 2, 5). Hyperdontia in the primary teeth was present in 89 subjects (35 females, 54 males). Two supernumerary teeth were present in 10 subjects (4 males, 6 females), and one single supernumerary tooth was present in 79 subjects. Upper and lower primary incisors represented almost the totality of the

cases (103 on a total of 105 teeth). The exceptions were an upper primary canine and a lower first primary molar. When two supernumerary teeth were present, they were both in the region of the upper lateral incisors in 8 cases, of the central upper incisors in one case, and of the upper lateral incisors and of the lower lateral incisors simultaneously in another case. The repetition in the permanent dentition of hyperdontia in the primary dentition was 60.7%.

Double teeth in the primary dentition were present in 54 subjects (22 females, 32 males). Gemination was diagnosed in 20 cases, while 34 cases were diagnosed as fusions. Gemination was followed by supernumerary teeth in the permanent dentition in 45% of the subjects (Tables 3, 5). Gemination affected the incisors in all cases. The anomaly involved the region of the upper central or lateral incisors in 9 cases, of the lower lateral incisors in 4 cases, and of the lower central incisors in one case. In 3 cases the anomaly affected 2 teeth. A low value for positive likelihood ratio (9.1) demonstrated the weak significance of gemination of primary teeth in terms of risk factor for supernumerary teeth in the permanent dentition.

A strong association was found between the presence of fusion of primary teeth and hypodontia in the permanent dentition (positive likelihood ratio = 47.0) (Tables 4, 5). Fusion was followed by hypodontia in the permanent dentition in 88.7% of the subjects. It involved only incisors and canines. In 3 cases the anomaly affected 2 couples of teeth (in 2 cases the lower central and lateral incisors, and in one case the lower lateral incisor and canine). Fusion involved upper central and lateral upper incisors in 7 cases, lower central and lateral incisors in 13 cases, and lower lateral incisor and canine in 17 cases. On a total of 16 fusions of the lower canine with the lateral incisor in the primary dentition, 15 cases showed missing lower permanent lateral incisors. Patients with fused lower primary lateral incisors and canines presented with a 93.7% occurrence of missing succedaneous lateral incisor.

In the control sample, on the total of 271 subjects 12 subjects showed hypodontia and 15 subjects exhibited hyperdontia in the permanent dentition in absence of previous anomalies of the primary dentition.

Discussion

The aim of the present investigation was to analyze the recurrence in the permanent dentition of dental anomalies in the primary dentition. This prospective longitudinal study evaluated a large sample of children and employed diagnostic performance tests as a statistical procedure [20].

Dental anomalies in the primary dentition are observed during routine dental examination, leading to orthodontic problems, including spacing or crowding of teeth, loss of

arch length, deviation of the midline, increased caries risk, and esthetic problems in preschool children [3, 6, 14, 18]. Only a few studies have been published on the prevalence of dental anomalies in the primary dentition and considerable variation exists in their findings, with prevalence rates ranging from 0.5 to 7%; this may reflect not only differences in study methodologies, but also variations in demographic and environmental susceptibilities [14, 19]. In the present study dental anomalies in the primary dentition as a whole were found in 2.3% of the investigated sample. It should be noted, however, that this prevalence was obtained in an orthodontic population that does not reflect the prevalence rate of the dental anomalies in the general population. A fundamental methodological feature of the current study was the inclusion of a control group for comparisons that belonged to the same population as the group with dental anomalies in the primary dentition.

Hypodontia in the primary dentition almost systematically re-presented itself in the permanent dentition (95.6%), with some exceptions. Both major previous studies [17, 19] reported complete repetition of hypodontia in the 2 dentitions. In the current study, 100% of repetition was observed for the absence of the primary central incisor, the primary upper canine, and the lower primary molar. Thirty-two out of 33 upper lateral incisors showed the repetition of the anomaly. In 4 cases the absence of one primary upper lateral incisor was followed by the absence of both permanent upper lateral incisors. In one case, 2 lower primary lateral incisors were absent, while 2 upper lateral incisors were absent in the permanent dentition. In another case with both missing upper primary lateral incisors, the anomaly affected only one permanent upper lateral incisor. In 2 cases, one with the absence of the lower right lateral incisor and one with both lower lateral incisors missing, the anomaly was not present in the permanent dentition. The observation of the to-date largest sample of dental anomalies in the primary dentition probably allowed for the inclusion of these exceptions with respect to previous reports. An interesting observation that can be derived from the longitudinal analysis of hypodontia in the 2 dentitions is that, besides the recurrence of the dental anomaly in both dentitions, other 2 possibilities may occur: (1) hypodontia in the primary dentition not followed by hypodontia in the permanent dentition (4.4% of the sample); (2) hypodontia in the permanent dentition not preceded by hypodontia in the primary dentition (4.4%, as derived from the analysis of the control sample). A possible explanation for these two uncommon events may be related to the complex multifactorial etiology of hypodontia [22]. In particular, it can be hypothesized that chromosomal, polygenic, single gene and environmental influences can affect differently the primary and the permanent dentition during different stages of tooth development.

Supernumerary teeth in the primary dentition are not to be considered a strong risk factor for hyperdontia in the permanent dentition, since the positive likelihood ratio was lesser than 10 (diagnostic performance is only “fair”): in 34 subjects, 3 with two supernumerary primary teeth, hypodontia in the primary dentition was not repeated in the permanent dentition. In 55 subjects (62 teeth) there was the presence of supernumerary teeth on the permanent dentition that were almost in all cases represented by the same tooth of the permanent series. The exceptions were represented by two cases in which the supernumerary teeth were located on the other side (upper right primary lateral incisor and upper left permanent incisor) and by one case in which the anomaly affected a lower tooth instead of an upper one on the other side (upper left primary lateral incisor and lower right permanent incisor). In one case the supernumerary primary tooth was followed by an hypodontia of the corresponding tooth in the permanent dentition.

Gemination of primary teeth showed a low score for likelihood ratio. In 8 of the 9 cases the anomaly affected the corresponding tooth of the permanent dentition, while in one case the anomaly was present in the region of the primary central incisor, and the supernumerary tooth was in the region of the permanent lateral incisor. The prevalence rate for repetition of gemination in the 2 dentitions reported here is in agreement with the data by Nik-Hussein and Abdul Majid [17] (59%) and by Skrinjarić and Barac-Furtinović [19] (61%). However, the diagnostic entity in both these studies was defined as “double teeth” in the primary dentition, which may have included some fusions as well.

A strong relationship was found between the presence of fusion of primary teeth and hypodontia in the permanent dentition (positive likelihood ratio = 46.96). Fusion was followed by hypodontia in the permanent dentition in 88.7% of the subjects. This prevalence is similar to the one reported by Hagman [18] (75%). Fusion of upper central and lateral incisor was followed by hypodontia of the lateral permanent incisor in 6 cases (on the total of 7). In one case the hypodontia was present also at the level of the upper lateral permanent incisor on the other side. In the only case in which there was not an hypodontia of the lateral permanent incisor, this tooth appeared small with a shape anomaly. The fusion between central and lateral lower incisors was followed by hypodontia of succedaneous teeth in 9 subjects (10 teeth). In two cases there were not consequences in the permanent dentition, in 9 cases there was hypodontia of the permanent lower central incisor, and in one case there was hypodontia of the permanent lateral lower incisor. In one of the cases with two fusions, the hypodontia involved only one permanent lower central incisor. When the fusion involved the lower lateral incisor and canine, there were consequences in the

permanent dentition with the only exception of one case. In 15 subjects there was an hypodontia of the lower lateral incisor, and in two subjects the two upper lateral incisors were absent too.

To summarize, in presence of dental anomalies in the primary dentition there is an increased likelihood of anomalies of the succedaneous permanent teeth. This likelihood is strong when the outcome in the permanent dentition is hypodontia, i.e. for hypodontia and fused teeth in the primary dentition, whereas it is rather weak when the outcome in the permanent dentition is hyperplasia, i.e. in cases of hyperdontia or geminated teeth in the primary dentition.

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