

# INFRAOCCLUSION OF DECIDUOUS MOLARS: A RETROSPECTIVE ANALYSIS OF PREVALENCE, CHARACTERISTICS AND ASSOCIATION WITH OTHER DENTAL ANOMALIES

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## SUMMARY

**Objective.** The aim of this study was to analyze the prevalence of infraocclusion of deciduous molars and the pattern of associations with other dental anomalies.

**Methods.** Digital panoramic radiographs of 5005 subjects were initially randomly selected from the files of the Department of Orthodontics of the University of Rome "Tor Vergata". According to the exclusion criteria, the final sample was composed of 4706 subjects. Each panoramic radiograph was examined to evaluate the presence of infraocclusion and other common dental anomalies. Prevalence and pattern of associations were studied between the anomalies.

**Results.** The prevalence rate of infraocclusion of deciduous molars was 2.8% with a male/female ratio of 1.5:1. The most frequent infraocclusion was mandibular second deciduous molars (48.4%). Considering the magnitude of infraocclusion, 68.4% of the affected molars were classified as mild infraocclusion, 27.1% as moderate and 4.4% as severe. The prevalence of mandibular infraocclusion was higher than maxillary infraocclusion (189:36). Subjects with infraocclusion of deciduous molars exhibited an association with impacted teeth, supernumerary teeth and with displacement of maxillary canine.

**Conclusion.** The findings of our study support infraocclusion of deciduous molars as a factor of a common genetic condition associated with other dental anomalies.

**Key words:** infraocclusion, primary molars, ankylosis, dental anomalies.

## Introduction

The term "infraocclusion" describes a condition, mostly found in primary molars, in which teeth's occlusal surface is positioned below that of the neighboring teeth, long after they should have reached occlusion (1). Some earlier common names for this dental anomaly have been used, such as: half retention, arrested eruption, buried tooth, tooth depression, disinclusion, impaction, incomplete/suppressed eruption, shortened tooth, intrusion, secondary retention, re-impaction, re-inclusion, retained deciduous tooth, tooth ankylosis, and sub-merged tooth. Now, "infraocclusion", referring to the chief visual feature of the abnormal-

ity, has become the term of preference for this positional anomaly of teeth (2).

Infraocclusion is usually associated to ankylosis. Despite being related, ankylosis is not always the cause of infraocclusion; on the other hand, infraocclusion can be a consequence of ankylosis.

It is generally agreed that the ankylosis between the roots of the primary tooth and the surrounding bone can determine an infraocclusion. As a consequence, the tooth involved is in a condition of static retention, whereas in the adjacent areas, eruption and alveolar growth continue. So that, the infraoccluded teeth appear to become progressively more submerged in relation to their neighbors over time. In some cases infraocclu-

sion remains static or it can even decrease (3). These teeth may present lack of mobility, solid sound to percussion, migration of neighboring teeth and reduction of dental arch perimeter (4). The etiology of infraoccluded teeth is still unclear (5), but several possible causes have been suggested: local metabolic anomaly, trauma, deficiency of alveolar bone growth, abnormal pressure of the soft tissues, and genetic factor (6). The hypothesis of a genetic origin for infraocclusion is supported by the presence of familial recurrence of the defect, by the expression of this dental anomaly in monozygotic twins and by studies assessing different prevalence of infraoccluded teeth in different races and populations (7, 8). Furthermore, it has been suggested that infraocclusion and other dental anomalies of shape, texture, number, and eruption may all represent micro symptoms of an inheritable disturbance because of a general disruption of the tooth developmental structures (9, 10).

Numerous factors may be involved in the process of infraocclusion such as: disturbed local metabolism, local mechanical trauma, infection, chemical or thermal irritation, local failure of bone growth, abnormal pressure from tongue, disturbance in the normal hard tissue resorption and deposition, systemic disease (e.g. congenital syphilis, endocrine disorders etc.), heredity, abnormal germ position and direction and lack of space.

The prevalence of infraocclusion of primary molars is most commonly reported to be 1.3-8.9% (11); however it can be as high as 38.5%. The major prevalence is in eight-to-nine year olds, with a higher incidence between siblings. Infraocclusion has been reported to be common in Caucasians with no gender bias noted. Overall, mandibular molars are more affected than maxillary molars (12). According to recent literature the mandibular first primary molar is the most commonly affected tooth. Infraocclusion often presents bilaterally with all teeth showing similar degrees of infraocclusion (13).

Clinically, it has been observed that several phenomena occur in association with the infraocclusion of primary teeth successor as marked tipping of the teeth adjacent to a severely infraoc-

cluded tooth is frequently seen, with only a minimal degree of space closure occurring. The degree of the tipping of the adjacent teeth, which appears to be quite different from that associated with space closure, caused by the early loss of primary teeth; delayed exfoliation; bone defects; increased susceptibility to dental caries and periodontal disease of both the neighbouring teeth; retained permanent molar.

Early diagnosis of the infraocclusion is essential for the establishment of effective preventive measures or treatment planning, including invasive procedures, always associated with adequate follow-up.

A diagnosis of infraocclusion is made by clinical examination where a disturbance in the occlusal plane is evident. These teeth have the classical, high-pitched, "cracked-teacup" sound of ankylosis when percussed with a metal instrument. Nevertheless, percussion tests are only clinically reliable in about one third of cases and depend heavily on the clinician's judgment of the quality of sounds (14).

Radiographic investigation is often recognized as an important diagnostic method in the diagnosis and follow-up of patients with infraoccluded teeth. A combination of a clinical and radiographic assessment is advised to rule out other causes, such as primary failure of eruption, impaction or other pathology (15).

Considering this background, epidemiological studies on large sample of growing subjects could reveal more information about the phenomena.

The aim of this study was to analyze the prevalence of infraocclusion of deciduous molars and the pattern of associations with other dental anomalies detectable on panoramic radiographs in a large sample of non-orthodontic growing subjects.

## Methods

The sample was recovered from the files of the Department of Orthodontics of the University of Rome Tor Vergata. Digital panoramic radi-

ographs (DPR) of 5005 subjects were initially randomly selected from January 2006 to July 2015. The inclusion criteria were: subjects of 8 to 12 years of age, Caucasian and good quality radiographs. In case of subjects with more than one panoramic radiograph, only the first one was evaluated. Exclusion criteria were: incomplete records (X-rays, clinical notes), syndromic and craniofacial subjects (e.g., cleft lip/palate), or a history of previous orthodontic. After applying the exclusion criteria this led to a final sample of 4706 subjects. From the initial sample of 4706 DPRs, 131 DPRs of subjects (52 females, 79 males) with a mean age of  $9.7 \pm 1.2$  years with at least one infraocclusion composed the study group (SG). Panoramic radiographs and dental casts of the SG were studied to determine the presence and severity of infraocclusion. The magnitude of infraocclusion was determined using a caliper with accuracy of 0.1 mm, following the Bjerklin and Bennett method (16). As reference was established the occlusal plane of the occlusal surface of the most distal and totally erupted molar, permanent first molar or primary second molar, in the evaluation of both sides of the arch (Figure 1). The magnitude of infraocclusion was measured using a perpendicular line drawn from the occlusal surface of the infraoccluded molar to the occlusal plane. Infraocclusions less than 1 mm was disregarded and 3



**Figure 1**  
Measurement of infraocclusion magnitude using a perpendicular line drawn from the occlusal surface of the infraoccluded molar to the occlusal plane of the permanent first molar.

scores of infraocclusion was established: mild (between 1.0 and 1.9 mm); moderate (between 2.0 and 2.9 mm); and severe (from 3 mm).

The SG was also examined to evaluate the presence of following dental anomalies: tooth agenesis or hypodontia (H), supernumerary tooth (ST), odontomas (O), tooth transposition (TT), impacted teeth (IT) and displacement of maxillary canine (DMC).

Hypodontia was assessed when no sign of crown calcification on the radiograph was evident (excluding the third molars) and no evidence of loss attributable to caries, periodontal disease, or trauma could be seen. The lower limit of the age (8 years) in the present sample was chosen to study hypodontia of all permanent teeth, excluding third molars, with minimal false-positive findings (17).

Supernumerary tooth was defined as the existence of an excessive number of teeth comparing to the normal dental formula (18).

Odontomas was determined by panoramic radiographic screening for the presence of a radiopaque mass composed of normal dental tissue grown in an irregular way. It presents in the compound form, by many little tooth-like structures held together, or, in the complex form, by a single amorphous mass (19).

Tooth transposition was identified by observation of dental casts and initial radiographic records as a positional interchange of two adjacent teeth, or the development or eruption of a tooth in a position normally occupied by a non-adjacent tooth (20).

Impacted tooth was defined as a disturbance of eruption determinate by some physical barrier in their path of eruption (21).

The presence of displacement of maxillary canine was diagnosed on the basis of initial radiographic records, if the subject was at least 9 years old at that time. For subjects younger at initial records, follow-up X-ray images were obtained later to confirm the presence of clear-cut DMC. According to the method described by Ericson and Kurol DMC was recorded when the crown of the permanent canine overlapped the root of the adjacent lateral incisor (22).

All images were evaluated independently by two

different operators (N.V. and G.L.) on a computer monitor in a quiet room with subdued ambient lighting. If there was disagreement between the investigators consensus was reached after discussion.

The Ethic Committee at the University of Rome Tor Vergata approved the study project (Protocol number: 188/16) and written consent was obtained from all subjects' parents.

## Statistical analysis

The data were analyzed by using SPSS software package (Statistical Package for Social Sciences, version 16.0, SPSS Inc., Chicago, USA). Descriptive statistics were used to describe the sample group in terms of age, sex, arch location, severity and prevalence rate of infraocclusion. Chi-Square test was used to evaluate significant associations between infraocclusion and different dental anomalies. Any P value < .05 was considered as significant. The prevalence and the patterns of association were assessed among different dental anomalies.

## Results

One hundred and thirty one subjects (2.8%) presented at least one infraocclusion. The SG aged between 8.0 and 11.7 with a mean age of 9.7 years, and a SD of 1.2 years. The male/female ratio of infraocclusion in SG was about 1.5:1. Table 1 shows sample sizes, age and gender distribution.

As many subjects presented multiple infraoccluded teeth, the total number of infraoccluded

teeth was 225, with a mean value of 1.7 infraocclusion per subject.

There were no significant differences in the distribution of infraocclusions when comparing the left and right hemiarch (114 infraocclusion on the right upper and lower hemiarch, 111 infraocclusion on the left upper and lower hemiarch). The prevalence of mandibular infraocclusion was higher than maxillary infraocclusion (189:36).

The distribution of infraocclusion, considering the type of molar involved, was: mandibular second deciduous molars (48.4%), mandibular first deciduous molars (35.5%), maxillary second deciduous molars (12.4%) and maxillary first deciduous molars (3.5%) (Figure 2).

Considering the three magnitude of infraocclusion, 68.4% (n. 154) of the affected molars were classified as mild infraocclusion (1.0 to 1.9 mm), 27.1% (n. 61) as moderate (2.0 to 2.9 mm) and 4.4% (n. 10) as severe (from 3 mm) (Table 2).

Subjects with infraocclusion of deciduous molars exhibited an association with impacted teeth ( $P<0.05$ ), with displacement of maxillary canine ( $P<0.01$ ) and supernumerary teeth ( $P<0.001$ ). Hypodontia, tooth transposition and odontomas was not considered statistically associated with infraocclusion (Table 3).

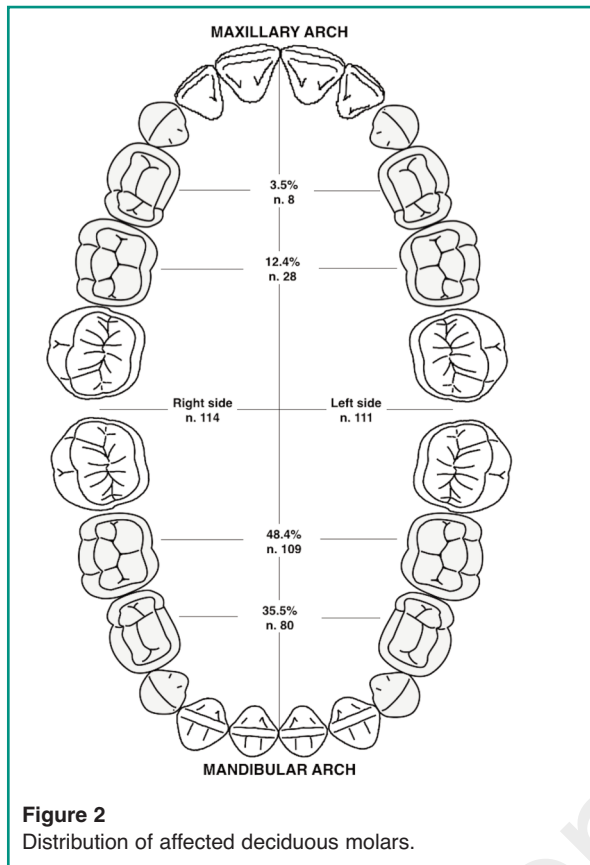
## Discussion

The aim of the present retrospective study was to test the incidence and the magnitude of infraocclusion of deciduous molars and the occurrence of certain other dental anomalies in subjects selected for clear-cut infraocclusion of one or more deciduous molars.

**Table 1** - Descriptive analysis of the sample.

	Subjects	Age	Standard Deviation	N° of infraoccluded teeth
<b>Male</b>	79	9.6	±1.2	132
<b>Female</b>	52	9.8	±1.3	93
<b>TOTAL</b>	131	9.7	±1.2	225





The topic is still much debated due to the lack of knowledge about its biological mechanisms. There are two main theories that intend to clarify the etiology of infraocclusion: the first one focuses on local clinical findings, while the second one focuses on genetics (7). According to the first theory, changes in the local metabolism of the periodontal ligament could provoke the fusion of the alveolar bone with the cementum,

leading to ankylosis (23).

By contrast, some Authors (11) have assessed family members of patients with infraocclusion and suggested the involvement of a genetic mechanism; furthermore, studies with monozygotic twins have shown that genetics play a determinant role in the etiology of secondary retention of deciduous molars.

According to literature, a discrepancy in the prevalence of infraocclusion has been reported among different age groups, confirming that infraocclusion prevalence is age-specific (11). In order to minimize variation in prevalence of infraocclusion caused by differences in age, our sample included a narrow age range of 8 to 12 years old, with all subjects in the late mixed dentition phase.

The diagnostic criteria used to evaluate whether a molar was or not infraoccluded was chosen according to Krakowiak method (24). He stated that a molar could be considered in infraocclusion when it loses contact with its antagonist and it is 0.5 mm below the occlusal plane. The definition of infraocclusion in this study as being a tooth 1 mm or more below the plane of occlusion is consistent with a number of published studies (10, 25).

Comparing to previous reports that evaluated infraocclusion on smaller samples than ours, the results of our study showed a low percentage of infraocclusion (2.8%).

Outcomes reported in literature differ widely. Published results include prevalence of 8.9% in 1059 Swedish children aged 3 to 12 years (26); 24.8% in 1530 Israeli children aged 2.5 to 13.5

**Table 2** - Infraocclusions magnitude distribution.

	Mild (1.0 to 1.9 mm)	Moderate (2.0 to 2.9 mm)	Severe (from 3 mm)
<b>Mandibular first molars</b>	55	21	3
<b>Mandibular second molars</b>	74	31	6
<b>Maxillary first molars</b>	6	2	0
<b>Maxillary second molars</b>	19	7	1
<b>TOTAL</b>	<b>154 (68.4%)</b>	<b>61 (27.1%)</b>	<b>10 (4.4%)</b>

**Table 3** - Pattern of associations with other dental anomalies and the corresponding p values, correlation coefficients and 95% confidence interval.

	Displacement of maxillary canine (DMC)	Hypodontia (H)	Impacted teeth (IT)	Tooth transposition (TT)	Supernumerary teeth (ST)	Odontomas (O)
<b>Infraocclusion</b>	<b>P&lt;0.01</b>	.051	<b>P&lt;0.05</b>	.110	<b>P&lt;0.001</b>	.376
	.040	.029	.132	.023	.083	0.13
	-.026-.105	-.037-.094	-.034-.097	-.042-.089	.017-.148	-.053-.078

P value < .05 was considered as significant

years (27) and 1.3% in 2342 American school-children of unspecified age (28). Zuñiga et al. in 2004 described infraocclusions in 10.48% of 849 children with age ranging from 3 to 12 years (29). Silvestrini et al. collected a group of 512 Italian subjects aged between 5 to 15 years and found an incidence of ankylosis of 6.6% (30). Silva et al. (2014) analyzed on orthopantomography a sample of 472 children from both genders between 3-13 years of age, complete primary dentition or mixed dentition; they found a prevalence of infraocclusion of 21.8% (4). A recent study conducted by Odeh et al. in 2016, using a new 2D image analysis methodology, evaluated two samples of 1454 singletons Finnish children and 270 Australian twins aged between 8 and 11 years. They found a prevalence of infraocclusion in the maxilla less than 1% and prevalence in the mandible of 22% in the singleton sample and 32% in the twin sample (13).

The great variability in reports may be explained by the different diagnostic criteria and/or by the different diagnostic methodologies, as well as by different criteria involved in sample selection (31). The sample source, age and ethnicity are factors that may influence results. The racial factors could have an important role in the development of submerged teeth.

As many subjects in the present study exhibited multiple infraoccluded teeth, the total number of infraoccluded teeth was 225, with a mean value of 1.7 infraocclusion per subject.

This data is consistent with similar results by Zuñiga et al. and Silva et al. who reported respectively 1.9 and 2.1 infraocclusions per child on similar samples (4, 29). However, Brearly et al. (25) and Kurol (11) reported higher percentages of infraocclusion affecting only one molar per child, respectively of 51% and 52%.

There was no significant difference in the prevalence of infraocclusion in relation to gender, according to the findings reported by previous studies that observed equal frequency for boys and girls (13, 24, 25). On the other hand, Steigman described a higher incidence of ankylosed mandibular second molars in males (32). No significant differences were detected in the distribution of infraocclusions, comparing the left and right hemiarch (114 infraocclusion on the right upper and lower hemiarch, 111 infraocclusion on the left upper and lower hemiarch) as assessed by previous reports (11).

Furthermore, the prevalence of mandibular infraocclusion, evaluated in our sample, was higher than maxillary infraocclusion (189:36). According with previous studies, in the mandibular arch, the incidence is 2 to 10-fold higher contrast to those of the maxillary arch (30, 32). On the other hand, De la Rosa et al. reported a higher percentage and severity in the maxilla (33).

In line with previous papers, the mandibular first primary molar was the most affected tooth (48.4%) (11, 27). According to Bjerklin and

Bennett method, the most observed category of infraocclusions was the mild degree one. Our results were consistent with the report of Brearly et al. (1973) (25) and Silva et al. (2014) (4), that used the same method, describing respectively 61.1 and 65% of mild, 27.8 and 28% of moderate and 11.1 and 2.5% of severe infraocclusions. Also Silvestrini et al. described similar findings using a different type of classifications (30).

Considering the type of molar, our results were in agreement with many reports that described mild and moderate infraocclusions more frequently in primary first molars which are rarely affected by severe infraocclusions. Instead, in second primary molars, severe infraocclusion showed a higher prevalence (25, 28, 33, 34). These results, according to Koyoumdjisky-Kaye et al. conclusions, may be referred to a later exfoliation and an increase in infraocclusion severity (27).

The significant association between infraocclusion and other dental anomalies, detected by our results, support the general consensus about the association with other anomalies, suggesting a shared genetic origin (3, 8, 11, 34).

Abnormal conditions such as tooth agenesis, microform teeth, delayed tooth development, palatally displaced canines (PDC) and mandibular second premolar distal angulation (MnP2-DA) has found to occur together much more frequently in subjects with infraocclusion than would be expected by chance. Combinations of these occurrences have been named dental anomaly patterns (abbreviated as DAP) by Peck (9).

Baccetti (1998), observed that infraocclusion of deciduous molars, agenesis of second premolars, microdontia of maxillary lateral incisors, PDC, ectopic eruption of maxillary first molars and enamel hypoplasia are frequently related dental anomalies (35).

Shalish et al., in a study conducted on 99 subjects with at least one deciduous molar in in-

fraocclusion, assessed a statistically significant association between the presence of infraocclusion and the occurrence of tooth agenesis, microdontia of maxillary lateral incisors, PDC, and MnP2-DA (2).

In opposition to the results previously reported, Rune et al., could not find any relationship between agenesis and infraoccluded primary molars (36). However, the mean age at the final registration was approximately 17 years; this data could create an age-based bias (e.g. the older subjects, already exfoliated some deciduous molars).

## Conclusion

- This retrospective study showed an incidence of deciduous molar infraocclusion of 2.8%; the lower deciduous molars (mainly second deciduous molars) were more frequently infraoccluded. The amount of infraocclusion was distributed as follows: mandibular second deciduous molars (48.4%), mandibular first deciduous molars (35.5%), maxillary second deciduous molars (12.4%) and maxillary first deciduous molars (3.5%).
- The three magnitude of infraocclusion were represented in the sample as follows: 68.4% (n. 154) mild infraocclusion (1.0 to 1.9 mm), 27.1% (n. 61) moderate (2.0 to 2.9 mm) and 4.4% (n. 10) severe (from 3 mm).
- Statistically significant associations were observed between the presence of infraocclusion and impacted teeth ( $P<0.05$ ), displacement of maxillary canine ( $P<0.01$ ) and supernumerary teeth ( $P<0.001$ ).
- These findings suggest that infraocclusion, despite being a transitory anomaly, may be considered an early marker for the development of later appearing dental anomalies and provide additional evidence to the hypothesis of causal genetic factors.

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