Malocclusions in primary and early mixed dentition in very preterm children

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Short title: Occlusal traits in very preterm children

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Abstract

Objective: To compare the prevalence of malocclusions in the primary and early mixed dentition of very preterm and full-term children.

Material and methods: Study subjects consisted of 205 very preterm (90 girls and 115 boys), and 205 age- and gender-matched full-term children. Data were collected from the register of Turku University Hospital (children born before the 37th week of pregnancy with a birth weight of less than 1,500 g, and all infants born before the 32nd week of pregnancy) and from public health centre dental registers.

Results: In primary dentition, case children had a higher odds of dental crowding (OR=2.94, 95% CI 1.17–7.35, p=0.021), a tendency toward increased overbite (OR=1.55, 95% CI 0.93–2.59, p=0.096), and a lower odds of increased overjet (OR=0.19, 95% CI 0.07–0.57, p=0.003) compared to control children. In early mixed dentition, there were no statistically significant differences in occlusal traits; however, case children were significantly more likely to have received orthodontic treatment (OR=2.80, 95% CI 1.50–5.23, p=0.001) compared to controls.

Conclusions: The results indicate that in primary dentition, the prevalence of malocclusion varies between very preterm and full-term children. In early mixed dentition, the distribution of occlusal traits is more similar.

Keywords: malocclusion, occlusal traits, orthodontic treatment, preterm birth

Introduction

According to the WHO definition, preterm children are born before the 37^{th} week of pregnancy or weigh less than 2,500 grams at birth. On the basis of pregnancy weeks, they can be classified into more specific categories: moderate to late preterm children are born between 32^{nd} and 37^{th} weeks of pregnancy, very preterm between 28^{th} and 32^{nd} and extremely preterm before the 28^{th} pregnancy week [1]. The majority of preterm births occur in developing countries [1], but Western countries, too, have high preterm birth rates. In Finland, approximately 5–6% of all children are born preterm; the share of very preterm births is less than 1% [2,3]. Preterm birth is usually caused by multiple factors, e.g., illness of foetus or mother, multiple pregnancies, and smoking [4,5]. However, in many cases the cause remains unknown.

During infancy, childhood and adulthood, preterm birth has numerous effects on children's physical and psychological development and health [6]. In 2014, about one in five infant deaths in the US were related to preterm birth and low birth weight [7]. Although preterm birth may cause long-term delays in a child's development, "catch-up" growth is seen in later childhood [8].

Preterm birth may also affect dental and occlusal development. While some researchers report delayed dental development and eruption [9], others fail to show differences between pre- and full-term children [10]. Preterm children have been suggested to have a high-arched palate and palatal grooving, although "grooving" especially lacks a uniform definition [11]. Further, the risk for posterior crossbite has been considered higher in pre- than full-term children [12]. According to Paulsson and coworkers [13], also increased overbite is significantly more common in pre- than full-term children. Moreover, Harila and coworkers [14] have reported that preterm children are prone to open bites.

This study had two aims: 1) to analyze whether very preterm children are more likely to have malocclusions in primary and/or early mixed dentition compared to full-term control children; and 2) to find out which of the malocclusions are more prevalent in very preterm than in full-term children. The hypothesis was that very preterm birth has an effect on occlusal development.

Material and methods

This register-based, longitudinal case-control study is part of the multidisciplinary PIPARI Study (Development and Functioning of Very Low Birth Weight Infants from Infancy to School Age, Turku University Hospital). The material for very preterm (case) children's occlusal traits was collected from two sources: (1) the register of the Turku University Hospital of children (a) born in 2001–2003 before the 37th week of pregnancy with a birth weight of less than 1,500 g, and (b) all infants born in 2004–2006 before the 32nd week of pregnancy; and (2) children's dental registers within public dental care. In Finland, dental care, including regular dental examinations, is provided free of charge to all children and adolescents up to 18 years of age. Dental examinations are carried out on an individual basis, usually at one- to three-year intervals, when no special risk factors (e.g., dental trauma, high risk for caries, deleterious dental habits) are present.

Of the 290 case children born in 2001–2006 at the Turku University Hospital, 205 were included in the study. A detailed description of the inclusion process has been presented earlier [15]. The maternal history of participating children was not available. Whenever intubation had been used during case children's perinatal hospital care, it was carried out through the nose.

There were 3–4 potential age- and gender-matched control children (n=636) for each case child. Control children were found in the register of the City of Turku Oral Health Care

(Health and Social Services). Of them, children born preterm or with some craniofacial anomaly or syndrome, and children with no dental information were excluded; the next child in the list with available information was selected as a control. The final material consisted of 205 case and 205 age- and gender-matched control children (90 girls and 115 boys in each group).

All data had been gathered and saved in electronic records as part of the normal daily practice of public health centres. One examiner collected and coded the data from the electronic dental records. In cases of deviating occlusal traits or malocclusions, the status was complemented with an orthodontic examination and/or free text message (concerning, e.g., delayed tooth eruption), and with radiographs as needed. Data included information on the child's gender, oral habits (non-nutritive sucking), overjet, overbite, dental and jaw relations, available space in dental arches, and orthodontic treatment history. Oral habits had been recorded in a structured way from six months to three years of age; thereafter, the situation was updated, if the habit persisted at three years or if there was any reason to suspect such a habit. Included data covered developmental stages from primary dentition to the completion of early mixed dentition. Data considering dental and occlusal relationships were always collected before any orthodontic treatment. All children having orthodontic treatment in primary dentition and their age and gender matched pairs were excluded from the analyses in the early mixed dentition stage.

The study protocol was approved by the Ethics Review Committee of the Hospital District of Southwest Finland in December 2000 (expires at the end of 2023) and by all included public health centres.

Statistical analysis

Especially in terms of primary dentition, dental information for several children was lacking. Data was analyzed by comparing the differences in malocclusions between case and control groups with descriptive statistics and logistic regression. The main statistical analyses for polytomous dependent variables were performed using multinomial logistic regression, and for dichotomous dependent variables using binary logistic regression. Generalized estimating equations with exchangeable correlation structure were used in logistic models to account for the case-control matched study design [16]. Two time points (primary and early mixed dentition stages) were analyzed separately. A total of four children (one case and three control children) had orthodontic treatment in the primary dentition, thus, they and their age and gender matched pairs were excluded from the analyses in the early mixed dentition stage. Results are expressed as odds ratios (OR) and 95% confidence intervals (CI). P-values of less than 0.05 were considered statistically significant in all tests (two-tailed). The analyses were performed using SAS system, version 9.4 for Windows (SAS Institute Inc., Cary, NC, US).

Results

Non-nutritional sucking

Data on non-nutritional sucking was obtained from 117 (57%) case and 167 (81%) control children. Both dummy sucking and finger (or other object like a cloth) sucking continued longer among case than control children; these differences were statistically significant ($p< 0.001$ and $p<0.008$, respectively). Any prolonged non-nutritive sucking habit continuing over two years of age was registered in 35% of case and 18% of control children ($p=0.001$). When the threshold was set at three years of age, the respective percentages were 17% and 9% ($p=0.041$). A detailed description of the occlusal traits among these case (n=20) and control children (n=15) is presented in Table 1.

Distribution of occlusal traits in the primary and early mixed dentition stages are presented in Table 2, and the results from the logistic regression analyses in Table 3.

Overjet

In primary dentition, the difference in overjet between case and control children was statistically significant. Case children had lower odds of having an increased overjet (≥ 4 mm) (OR=0.19, CI 0.07–0.57, p=0.003). In early mixed dentition, an overjet of more than 6 mm was registered in 4.4% of case and 6.8% of control children.

Overbite

In primary dentition, case children had a tendency toward higher odds of having an increased overbite (OR=1.55, 95% CI 0.93–2.59, p=0.096). The same difference was not observed in the early mixed dentition stage. Of children with an overbite of more than 4 mm in early mixed dentition, the overbite was traumatic (with gingival contact) in 5.4% of both case and control children.

Crowding

Case children had significantly higher odds of crowding in primary dentition (OR=2.94, 95% CI 1.17–7.35, p=0.021) than control children. This difference was not seen in early mixed dentition.

Orthodontic treatment history

In primary dentition, one case child and two control children had been treated with an expanding quad helix appliance because of a posterior crossbite. In addition, one of the control children had been treated in a private dental office; information regarding this treatment was not available.

In the early mixed dentition stage, 41 of the 191 case children and 17 of 191 control children with data on orthodontic treatment history had received orthodontic treatment. Thus, case children were significantly more likely to have had orthodontic treatment (OR=2.80, 95% CI 1.50–5.23, p=0.001) than control children. In both groups, the share of orthodontic treatment was similar between boys and girls (22.2% of case boys and 20.5% of case girls vs. 8.4% of control boys and 9.5% of control girls). Among case children, the most commonly used appliance was an individually made activator or a prefabricated eruption guidance appliance (n=18), followed by one arch fixed appliance (n=12). Among control children, a fixed appliance was most common (n=11).

[Table 1, Table 2 and Table 3 near here]

Discussion

The present study indicated some differences in the prevalence of malocclusions between case and control children. In primary dentition, crowding was almost threefold and spacing twice as common in preterm children compared to their full-term counterparts. In early mixed dentition, these differences had disappeared; in both groups, crowding was reported in 38% and spacing in less than 14%. Interestingly, the prevalence of spacing was essentially smaller than reported earlier for 8–10-year-olds (43% in very preterm and 29% in control children) [13], whereas current results indicated significantly more crowding. However, the percentages (8% in very preterm, 5% in control children) by Paulsson et al. [13] only include crowding of 5 mm or more; in the current study, the extent of crowding was unfortunately not defined in many cases.

Excessive overbite was found in 32% of preterm and 22% of control children. These numbers are clearly higher than those reported in primary dentition (8% of preterm and 14% of control children) [17]. In a recent study, a still higher prevalence rate (39%) was reported among Estonian 4–5 -year-olds; however, the applied threshold for increased overbite was slightly lower [18]. Paulsen et al. [13] reported that in the group of 8–10-year-olds, 27% of very preterm children had an overbite exceeding 4 mm, while the prevalence of deep bite in our case and control children at that stage was double. Although in the study by Sepp et al. [19], more than every second Estonian 7–10 –year-old was reported to have an overbite of at least 3.5 mm, even here the threshold was clearly lower than that applied in current study (≥ 3.5 mm vs. ≥ 5mm).

The share of excessive overjet was higher among two-year-olds (23% preterm, 32% controls) [17] than in the current study. On the other hand, the share in our control children (23%) corresponded to that reported in Finnish children (27%) [20]. In early mixed dentition, an overjet exceeding 6 mm was found in 13% of case children, which is lower than the 24% prevalence reported by Paulsson et al. [13]. Again, it shall be noted that even slightly different threshold values make comparisons between studies difficult.

Anterior open bite and posterior crossbite are commonly seen in children with non-nutritive sucking habits, atypical swallowing and mouth-breathing [21,22]. In this study, systematic assessments of breathing pattern (oral/nasal) were not done, because they do not include in daily routins in public health centres. However, according to the records, some of the children had had adenoidectomy indicating at least potential for partial airway obstruction; some of them had recurring respiratory infections, otitis media, and allergies. Because anamnestic data considering children's general health were not collected, these occasional notes were left unanalyzed.

In a recent study, [23] the risk of non-nutritive sucking habits in preterm children was found to be more than threefold in comparison with full-term children. In light of this finding the share of anterior open bite and posterior crossbite seem low, around 10%. In primary dentition, Primozic et al. [17] found anterior open bite in one of four and Germa et al. [12] in one of three preterm children; in the latter study, the share of posterior crossbite was about 30%. The differences between these numbers and our results are most likely a consequence of the recommendation of the Finnish Dental Society that dummy sucking should be given up no later than at two years of age. This recommendation is reinforced at all child welfare clinics. The threshold age of two years has also been suggested by Warren et al. [24].

An interesting finding in this study was that a significantly higher number of case (n=41) than control children (n=17) had received orthodontic treatment in early mixed dentition, although there were no statistically significant differences in the prevalence of occlusal traits. Case children were usually treated with an activator or eruption guidance appliance designed for treatment of sagittal and vertical relationships. Although in control children, Class II sagittal relationship was more common than in case children, and a deep bite was observed in every second control child, control children were in most cases treated with a fixed appliance.

In our study, we compared data on very preterm and age- and gender-matched full-term control children. All 205 preterm children were born in the same hospital, and during their perinatal hospital care had been treated according to the same principles. None of the children had been intubated through the mouth. The rather large, uniformly treated sample can been seen as a strength of this study. However, there are limitations as well. First, oral habits were recorded in a structured way from six months up to three years of age. However, these data covered only 57% of case and 81% of control children. It is possible that medical conditions of some very preterm children prevented their participation in oral examinations at this early age. Moreover, some of the control children had moved to the region first when they were older, which explains at least partly the lack of data on primary dentition. The second limitation is related to the fact that all data were produced in public health centres during routine dental and oral examinations, and collected retrospectively from structured electronic records and the additional free text messages. Consequently, there were no clearly defined categories, e.g., for crowding or spacing.

Conclusions

On the basis of the current findings,

- in primary dentition, very preterm children have a higher likelihood of crowding and an increased overbite compared to control children; their odds of an increased overjet are lower
- one in three very preterm children has a deep overbite, while the corresponding ratio of full-term children is about one in five
- in early mixed dentition, the distribution of occlusal traits is similar in very preterm and full-term children

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Table 1. Percentage distribution of occlusal traits during primary and early mixed dentitions among pretem case (N=20) and control children (N=15) with prolonged sucking over three years of age.

PRIMARY DENTITION			EARLY MIXED DENTITION		
	Case n (%)	Control n (%)		Case n (%)	Control n (%)
SAGITTAL MOLAR RELATIONSHIP					
Flush terminal plane (normal)	8 (72.7)	6 (66.7)	Class I	5 (31.3)	5 (33.3)
Distal step	2 (18.2)	3 (33.3)	Class II	9 (56.3)	8 (53.3)
one side normal /one side distal step	1 (9.1)	0 (0.0)	one side Class I/ on side Class II	2 (12.5)	2 (13.3)
Mesial step	0 (0.0)	0 (0.0)	Class III	0 (0.0)	0 (0)
OVERJET					
1–3 mm	6 (66.7)	1 (25.0)	0–5 mm	12 (70.6)	11 (78.6)
≤ 0 mm	0	0	< 0 mm	0 (0.0)	0 (0.0)
≥ 4 mm	3 (33.3)	3 (75.0)	≥ 6 mm	5 (29.4)	3 (21.4)
OVERBITE					
0–3 mm	8 (44.4)	3 (20.0)	0–4 mm	9 (47.4)	10 (66.7)
< 0 mm, open bite	7 (38.9)	12 (80.0)	< 0 mm	3 (15.8)	2 (13.3)
≥ 4 mm	3 (16.7)	0 (0.0)	≥ 5 mm	7 (36.8)	3 (20.0)
TRANSVERSAL RELATIONSHIP					
normal	15 (83.3)	12 (80.0)	normal	15 (79.0)	13 (86.7)
cross- or scissorsbite	3 (16.7)	3 (20.0)	cross- or scissors bite	4 (21.5)	2 (13.3)
SPACE RELATIONSHIP					
normal	14 (77.8)	15 (100.0)	normal	11 (57.9)	6 (40.0)
crowding	2 (11.1)	0 (0.0)	crowding	6 (31.6)	5 (33.3)
spacing	2 (11.1)	0 (0.0)	spacing	2 (10.5)	4 (26.7)

Table 2 Percentage distribution of occlusal traits during different developmental stages among preterm (case) children (N=205) and age and gender matched control children (N=205). In early mixed dentition stage four children (one case and threecontrol children and their age and gender matched pairs) were excluded from the study groups due to orthodontic treatment performed in primary dentition stage.

PRIMARY DENTITION			**EARLY MIXED DENTITION**		
	Case n (%)	Control n (%)		Case n (%)	Control n (%)
SAGITTAL MOLAR RELATIONSHIP					
Symmetric					
Flush terminal plane (normal)	90 (73.2)	80 (75.5)	Class I	97 (57.1)	86 (47.8)
Distal step	14 (11.4)	20 (18.9)	Class II	45 (26.5)	62 (34.4)
Mesial step	13 (10.6)	0 (0)	Class III	2 (1.2)	0 (0)
Asymmetric					
one side normal/ one side distal step	6 (4.9)	6 (5.7)	one side Class I/ one side Class II	25 (14.7)	32 (17.8)
one side normal/ one side mesial step	0 (0)	0 (0)	one side Class I/ one side Class III	1 (0.6)	0 (0)
OVERJET					
1–3 mm	82 (91.1)	51 (72.9)	0–5 mm	135 (86.0)	144 (82.3)
≤ 0 mm	3 (3.3)	3 (4.3)	< 0 mm	2 (1.3)	3 (1.7)
≥ 4 mm	5 (5.6)	16 (22.9)	≥ 6 mm	20 (12.7)	28 (16.0)
OVERBITE					
0–3 mm	107 (59.8)	115 (65.3)	0–4 mm	80 (41.7)	88 (46.6)
< 0 mm, open bite	15 (8.4)	22 (12.5)	< 0 mm	8 (4.2)	4 (2.1)
≥ 4 mm	57 (31.8)	39 (22.2)	≥ 5 mm	104 (54.2)	97 (51.3)
TRANSVERSAL RELATIONSHIP					
normal	159 (89.3)	157 (88.7)	normal	164 (85.4)	160 (83.8)
crossbite	18 (10.1)	18 (10.2)	crossbite	25 (13.0)	29 (15.2)

scissor bite	1 (0.6)	2 (1.1)	scissor bite	3 (1.6)	2 (1.0)
SPACE RELATIONSHIP					
normal	145 (81.9)	165 (92.7)	normal	100 (52.4*)	103 (53.9*)
crowding	19 (10.7)	7 (3.9)	crowding	74 (38.7)	72 (37.7)
spacing	13 (7.3)	6 (3.4)	spacing	26 (13.5)	25 (13.1)

* 8 children in the case group and 9 children in control group had both crowding and spacing

Table 3. Comparison of the prevalence of occlusal traits during primary and early mixed dentition among preterm (case) children (N=205) and age and gender matched control children (N=205). In early mixed dentition stage four children (one case and three control children and their age and gender matched pairs) were excluded from the study groups due to orthodontic treatment performed in primary dentition stage.

PRIMARY DENTITION			**EARLY MIXED DENTITION**		
	Case vs Control (95% CI)	P-value		Case vs Control (95%)	P-value
SAGITTAL MOLAR RELATIONSHIP					
Flush terminal plane (normal)	1		Class I (normal)	1	
Distal bite	0.62 (0.30 - 1.30)	0.208	Class II	0.65 (0.38 - 1.09)	0.103
Unilaterally normal	0.74 (0.29 - 1.93)	0.538	Unilaterally normal	0.74 (0.42 - 1.30)	0.296
OVERJET					
1–3 mm	1		0–5 mm	1	
≤ 0 mm	0.62 (0.12 - 3.26)	0.579	< 0 mm	0.72 (0.12 - 4.29)	0.714
≥ 4 mm	0.19 (0.07 - 0.57)	0.003	≥ 6 mm	0.76 (0.41 - 1.43)	0.403
OVERBITE					
0–3 mm	1		0–4 mm	1	

< 0 mm	0.76 (0.36 - 1.58)	0.456	< 0 mm	2.29 (0.64 - 8.18)	0.201
≥ 4 mm	1.55 (0.93 - 2.59)	0.096	≥ 5 mm	1.18 (0.80 - 1.74)	0.399
TRANSVERSAL RELATIONSHIP					
Normal	1			1	
Crossbite / Scissor bite	0.94 (0.48-1.82)	0.853		0.88 (0.51-1.54)	0.657
SPACE RELATIONSHIPS					
Normal	1		Normal	1	
Crowding	2.94 (1.17 - 7.35)	0.021	Crowding	1.05 (0.69 - 1.59)	0.836
Spacing	2.26 (0.83 - 6.17)	0.112	Spacing	1.04 (0.58 - 1.85)	0.894