Anterior Tooth Crowding and Prevalence of Dental Caries in Children in Szczecin, Poland

J. Buczkowska-Radlinska[1], L. Szyszka-Sommerfeld[2] and K. Wozniak[2]

[1]*Department of Conservative Dentistry, Pomeranian Medical University, Szczecin, Poland.* [2]*Department of Orthodontics, Pomeranian Medical University, Szczecin, Poland*

Objective: To test the effect of anterior tooth crowding on dental caries in Polish patients with primary, mixed and permanent dentition. ***Basic research design***: Dental examinations based on WHO criteria and questionnaire surveys were performed on 225 children from Poland selected by stratified random sampling. The mean dmft/DMFT scores were recorded for primary, mixed and permanent dentition. Multivariate logistic regression was performed to identify associations between caries prevalence and other possible caries risk factors including crowding. ***Results:*** The study population had high overall caries prevalence. Both caries prevalence and DMFT in anterior teeth of 15-19 year old adolescents with crowding were higher than in those without crowding. Multivariate analysis showed that the risk factors associated with anterior caries prevalence in patients aged 15-19 years were crowding (OR 3.71) and tooth brushing twice a day or less without interdental cleaning (OR 2.15). ***Conclusions:*** Tooth crowding may have been associated with anterior caries experienced in children aged 15-19 years and must be taken into consideration as a caries risk indicator.

Key words: caries risk, crowding, dental caries

Introduction

Dental caries is the most common multifactorial oral disease affecting children and adolescents. Bacterial plaque is the only immediate, direct factor causing caries. However, a number of distinct factors determine the level of bacterial activity and for dental caries a diet high in free sugars is the most important one. In addition, the outcome of the bacterial activity in terms of causing damage to the teeth is controlled by several other factors, such as fluorides, saliva secretion, buffer capacity and salivary antibodies which collectively provide resistance to caries development (Bratthall, 1996). Associations between dental caries and different caries risk factors, such as sugar consumption (Declerck *et al.*, 2008; Marshall *et al.*, 2005), oral hygiene habits, exposure to fluoride and socioeconomic status (Sogi and Bhaskar, 2002; Wierzbicka *et al.*, 2002) have already been documented.

Tooth crowding is one of the most frequent orthodontic anomalies (Staufer and Landmesser, 2004). While some epidemiological studies found a positive association between the prevalence of dental caries and crowding (Gábris *et al.*, 2006), others could not establish any significant relationship (Stahl and Grabowski, 2004). Studies have identified some associations between crowding, caries and periodontal disease. This supports the observation that crowded teeth make effective oral hygiene more difficult and consequently may predispose the teeth to the development of dental caries, especially when accompanied by average cleaning habits. Crowding causes restricted access for the toothbrush and the natu-ral cleansing of the teeth by the tongue and saliva and provides additional retention areas for food and microbial plaque (Ainamo, 1972; Buckley, 1981). However, this association is somewhat controversial, primarily because of interplay of a number of factors which makes the determination of the role of tooth irregularity difficult (Addy *et al.*, 1988). There are no population data linking tooth crowding and caries in Polish children of different ages with the risk factors for dental caries.

The objective of this study was to test the effect of anterior tooth crowding on dental caries in patients with primary, mixed and permanent dentition, among other possible risk factors for dental caries. It was hypothesised that there is no difference in caries prevalence and severity in patients aged 3-5, 6-9 and 15-19 years between children with and without anterior crowded teeth.

Methods

The study was approved by the Research Ethics Committee of the Pomeranian Medical University 17 December 2007 under number BN-001/134/07. Parental consent was also obtained for subjects to be examined prior to the survey.

A study population of the age groups 3-5 (I, primary dentition), 6-9 (II, early mixed dentition) and 15-19 years (III, permanent dentition) was selected by stratified random sampling from kindergartens and primary and high schools in Szczecin, a city of 406,000 inhabitants in north-west Poland. The study was carried out between March and April 2009. Three hundred 3-19 year-old children were randomly selected from across

Correspondence to: Dr L. Szyszka-Sommerfeld, Department of Orthodontics, Pomeranian Medical University, Al. Powst. Wlkp. 72, 70-111 Szczecin, Poland. E-mail: liliana.szyszka@gmail.com

3 kindergartens, 2 primary and 2 high schools from the area's 55 kindergartens, 41 primary schools, and 36 high schools. The schools were chosen from two districts covering different socio-economic backgrounds. The 7 selected schools provided lists of all children, their ages and gender. Two classes were randomly selected from each school and all 300 children from those classes were asked to participate. Parents and children were informed of the study and made aware of the fact that participants could withdraw from the study at any time. Only consenting subjects were included in the study. Selected children fulfilled the inclusion criteria of being in one of the defined age groups. Children with orthodontic treatment prior to examination were excluded from the study. Primary dentitions were examined in the 3-5-year-olds. In the 6-9-year olds both primary and permanent teeth were examined. Only the 15-19-yearold's permanent teeth, excluding third molars, were assessed.

Data were collected from dental records, by clinical examinations of the children and through parental questionnaires (groups I, II) or by the children (group III) during the dental visits. The parents or children were asked about their systemic diseases (no 0, yes 1), regular dental visits (yes 0, no 1), oral hygiene habits (frequency of tooth brushing; at least twice a day with interdental cleaning 0, twice a day or less without interdental cleaning 1), frequency of use of fluoride toothpaste and other fluoride dentifrices (toothpaste and other fluoride dentifrices twice a day 0, toothpaste twice a day 1, toothpaste once a day 2), dietary habits (frequency of consumption of sweetened drinks and sweets; occasionally or never 0, three times a day 1, more than three times a day 2), and socioeconomic status (high 0, medium 1, low 2) (Wierzbicka, 2006). Socioeconomic status was assessed by mothers' educational level and family income. Maternal educational level was stratified into categories 1-8: incomplete primary; primary; vocational; incomplete secondary; secondary; post-secondary; incomplete higher; and higher education. Data on monthly family income per person were collected (in local currency, PLN) and then stratified into categories 1-3: <301; 301-700; >700. SES was defined as the product of these two variables. The product (range 1-24) was quantified to three SES bands: low (1-5), medium (6-14) and high (>14).

The dental examinations were carried out by two experienced clinicians from the Pomeranian Medical University, Szczecin who assessed caries, oral hygiene and tooth crowding. Training in epidemiologic/clinical methodology and calibration of the examiners prior to the study were performed during a similar survey of Polish children, where the examiners and supervisor jointly examined subjects and discussed the findings, according to the diagnostic criteria below. This process continued until reliability was achieved. The training ended with double examination of 20 children yielding an intraexaminer kappa value of 0.8. The clinical examinations of the children were performed by having patients seated in a school chair and were based on the WHO methodology (WHO, 1997). First, the teeth were cleaned and dried using sterile gauze, cotton wool and compressed air. All teeth were clinically examined using a dental mirror, blunt probe, and optimal lighting. No radiographs were included. Decayed, missing, and filled teeth were recorded for primary (dmft), mixed and permanent dentition (DMFT). Premature loss of primary teeth due to caries was considered when primary teeth were missing 2 years before their normal exfoliation. When permanent teeth were missing a history of the reason for tooth extraction was obtained in order to ensure that orthodontic extractions were not included in the M component. Oral hygiene practice was determined from the above questionnaires on tooth brushing frequency and by measuring dental plaque, using the Approximal Plaque Index (API, Lange, 1977). APIs from 70-100% were graded as poor, 40-69% as inadequate, 39-25% as good and under 25% as very good oral hygiene.

The assessment of tooth crowding was performed on dental casts of the children after the clinical examinations. Only the anterior crowded teeth (maxillary and mandibular incisors and canines) were taken into consideration. Crowding was defined as one or more teeth rotated by 15° or more from the normal position in the arch, or at least 2mm out of line, whereby space would have to be created to allow correction of malalignment. Patients without crowding or crowding less than 2mm formed a control group, since this type of crowding is considered as "still almost" physiologic (Staufer and Landmesser, 2004).

Collected data were analyzed using STATISTICA 7.0 PL for Windows with the level of statistical significance set at 5%. Analysis was performed using the Chi-square test, Mann-Whitney U test and multivariate logistic regression. The Chi-square test compared the number of children with caries (dmft/DMFT>0) between groups with and without crowding. Mann-Whitney U tests compared dmft/DMFT and API values between groups of children with and without crowding. Multivariate logistic regression was performed to identify relationships between caries experience (or lack thereof) in anterior teeth as a dependent variable and other caries risk factors, particularly crowding, as independent variables. The results were reported using odds ratio (OR), 95% confidence interval (CI) and p-value.

Results

There were 225 participating children: 72 in group I, 86 in group II and 67 in group III. Numbers in sub-groups by age and (a) with and (b) without anterior crowded teeth are shown in Table 1. The study population had high overall caries prevalence with all the children in half the groups having caries (Table 1). There were no significant differences between children with and without anterior crowding for caries prevalence or mean dmft/DMFT scores for all teeth for any age group.

The numbers of children with caries in anterior segments of dental arches with crowded teeth are shown in Table 2. Children in group III with anterior crowding were more likely to have caries than those without. In the same group, 15-19 year-olds, children had significantly more caries if they had anterior crowding.

The accumulation of dental plaque measured by Approximal Plaque Index (API) was statistically significantly higher in patients with anterior crowded teeth across all age groups (Table 3). According to the API and tooth brushing frequency, oral hygiene was generally inadequate. Only those in groups Ib and IIIb had good oral hygiene.

Table 4 shows the relationships between anterior caries experience and other caries risk factors, particularly crowding in patients with permanent dentition. The anterior caries experience was associated with crowding, (OR 3.71) and with tooth brushing twice a day or less without interdental cleaning (OR 2.15).

Discussion

The primary aim of this study was to explore the relationship between orthodontic anomalies such as anterior crowding and dental caries in patients with primary, mixed and permanent dentition. The results indicate that anterior tooth crowding in 15-19-year-old patients results in more dental caries. Anterior caries prevalence and mean DMFT scores for anterior teeth were higher in children with crowded teeth than in patients without crowding in permanent dentition. Previous experiences showed a limited correlation between the DMFT index and crowded teeth, although crowding may have had a negative influence on the state of the dental hard tissue over the long term (Koch, 1994). These observations may indicate that dental caries has a chronic course, developing over several years. Age reflects the time the teeth remain in the oral cavity and the time period for which different caries factors may act on mineralized tooth tissues. For the patients aged 15-19 with permanent dentition, this period was at least several years and was definitely longer than in children from the younger age groups. Children with crowded teeth in primary and mixed dentition did not have more caries than children without crowding. The lack of relationship between crowding and dental caries in the anterior teeth in primary and mixed dentition may be related to the shorter period of exposure to caries promoting conditions.

Table 1. Caries prevalence and mean dmft/DMFT values for all teeth in patients aged 3-5, 6-9 and 15-19 years (a) with and (b) without anterior tooth crowding

Group		n	Children with dmft/DMFT>0 n	(%)	p-value	Mean dmft/DMFT Mean	(sd)	p-value
3-5y	Ia	31	22	(71.0)	0.346	3.62	(2.85)	0.340
	Ib	41	33	(80.5)		3.83	(2.78)	
6-9y	IIa	42	42	(100.0)	0.326	7.17	(3.19)	0.735
	IIb	44	43	(97.7)		7.14	(3.62)	
15-19y	IIIa	34	34	(100.0)	1.000	8.59	(3.64)	0.065
	IIIb	33	33	(100.0)		6.88	(3.97)	

Table 2. Caries prevalence and mean dmft/DMFT values for anterior teeth in patients aged 3-5, 6-9 and 15-19 years (a) with and (b) without anterior tooth crowding

Group		n	Children with dmft/DMFT>0 n	(%)	p-value	Mean dmft/DMFT Mean	(sd)	p-value
3-5y	Ia	31	15	(48.4)	0.222	1.55	(2.11)	0.162
	Ib	41	14	(34.1)		0.85	(1.44)	
6-9y	IIa	42	21	(50.0)	0.052	0.76	(0.96)	0.089
	IIb	44	13	(30.0)		0.52	(0.98)	
15-19y	IIIa	34	17	(50.0)	0.014	1.18	(1.49)	0.008
	IIIb	33	7	(21.2)		0.33	(0.69)	

Table 3. Mean percentage API in the age groups 3-5, 6-9 and 15-19 years for groups with and without anterior tooth crowding

With anterior tooth crowding					Without anterior tooth crowding				
Group		n	Mean API [%]	(sd)	Group	n	Mean API [%]	(sd)	p-value
Ia	3-5y	31	44.8	(21.1)	Ib	41	28.9	(16.6)	0.001
IIa	6-9y	42	51.3	(15.3)	IIb	44	41.1	(20.3)	0.005
IIIa	15-19y	34	49.0	(23.3)	IIIb	33	34.5	(18.0)	0.012

Table 4. Anterior caries experience in patients with permanent dentition (multivariate logistic regression analysis)

Independent variable	n	Odds Ratio	95% CI	p-value
Crowding				
No (reference category)	24	1.00		
Yes	43	3.71	1.27-10.85	0.016
Systemic diseases				
No (reference category)	62	1.00		
Yes	5	0.32	0.00-1.29	0.825
Regular dental visits (once a year)				
Yes (reference category)	55	1.00		
No	12	1.17	0.29-4.79	0.826
Tooth brushing frequency				
At least twice a day with interdental cleaning (ref)	30	1.00		
Twice a day or less without interdental cleaning	37	2.15	1.10-4.57	0.047
Frequency of fluoride usage				
Toothpaste and other fluoride dentifrices twice a day (ref)	13	1.00		
Toothpaste twice a day	44	2.75	0.61-12.33	0.187
Toothpaste once a day	10	2.83	0.42-19.02	0.285
Frequency of consumption of sweetened drinks				
Occasionally or never (reference category)	18	1.00		
Three times a day	35	0.65	0.18-2.33	0.508
More than three times a day	14	2.34	0.49-11.16	0.287
Frequency of consumption of sweets				
Occasionally or never (reference category)	32	1.00		
Three times a day	32	0.52	0.17-1.59	0.254
More than three times a day	3	0.50	0.04-6.97	0.609
Socioeconomic level				
High (reference category)	33	1.00		
Medium	32	1.63	0.56-4.77	0.372
Low	2	0.90	0.00-4.32	0.324

There are limitations to generalizing the findings and the data collected from examinations should be interpreted with caution. Since the number of children in some of the groups is small, and the observed differences are based on data from sub-groups, there is a need for further research based on larger samples to validate the obtained results.

The data reveal that orthodontic anomalies such as crowding may also be associated with susceptibility to plaque retention in all examined groups. Other researchers found a relationship between malocclusion, particularly crowding and dental plaque, gingival bleeding and calculus in children aged 7-17 (Alexander *et al.*, 1997). Gábris *et al.* (2006) observed a relation between the presence of malocclusion, dental plaque and caries experience in 16-18-year-old Hungarians. In contrast, Ashley *et al.* (1998) found no relationship between irregularity of incisor teeth and amounts of plaque in 11-14-year-old children. Addy *et al.* (1988) claim that irregular teeth retain more plaque than straight teeth in 11-12-year-olds, although with no difference in the incidence of dental caries. However, direct comparison with other studies is confounded by differences in the ages of the subjects.

In the present study, the patients with permanent dentition that brushed teeth twice a day or less without interdental cleaning had 2.15 times higher probability of having anterior dental caries than children who brushed teeth at least twice a day with using others dentifrices including fluoride to maintain good hygiene of the interproximal surfaces. Tooth brushing at least twice a day with a fluoride dentifrice is regarded as an effective method of preventing dental caries (Carlile and Eaton, 2008; Levin and Currie, 2010). However, tooth brushing alone, does not reach the interproximal areas of the dentition, which means that part of the dentition is left unclean. As the interproximal surfaces of the teeth are frequently affected by caries, interdental cleaning represents an important aspect of oral self-care (Berchier, 2008).

This sample of Polish children aged 3-5, 6-9 and 15-19 had high overall caries prevalence. Dental caries remains a serious problem in Poland. There is a need for oral health promotion, particularly with respect to very young children. It is necessary to improve public caries prophylaxis programmes by taking into consideration anterior tooth crowding as a factor increasing a caries risk. The positive correlation between tooth crowding and the prevalence of dental caries and plaque requires a careful attention to the possibilities of caries prevention through early diagnosis and orthodontic treatment of dental anomalies, such as crowding of teeth, and proper hygiene of interdental spaces.

Conclusions

This study showed that in adolescents anterior crowding and tooth brushing twice a day or less without interdental cleaning can be considered risk factors for dental caries. Knowledge about the influence of crowded teeth on dental caries and the accumulation of dental plaque is important in planning dental services and preventive strategies, including orthodontic diagnostic and treatment.

References

Addy, M., Griffiths, G.S., Dummer, P.M.H., Kingdon, A., Hicks, R., Hunter, M.L., Newcombe, R.G. and Shaw, W.C. (1988): The association between tooth irregularity and plaque accumulation, gingivitis, and caries in 11-12-year-old children. *European Journal of Orthodontics* **10**, 76-83.

Ainamo, J. (1972): Relationship between malalignment of teeth and periodontal disease. *Scandinavian Journal of Dental Research* **80**, 104-110.

Alexander, S., Hedge, S. and Sudha, P. (1997): Prevalence of malocclusion and periodontal status in Tibetan schoolchildren of Kushalnagar, Mysore district. *Journal of Indian Society of Pedodontics and Preventive Dentistry* **15**, 114-117.

Ashley, F.P., Usiskin, L.A., Wilson, R.F. and Wagaiyu, E. (1998): The relationship between irregularity of the incisor teeth, plaque, and gingivitis: a study in a group of schoolchildren aged 11-14 years. *European Journal of Orthodontics* **20**: 65-72.

Berchier, C.E., Slot, D.E., Haps, S. and Van der Weijden, G.A. (2008) : The efficacy of dental floss in addition to a toothbrush on plaque and parameters of gingival inflammation: a systematic review. *International Journal of Dental Hygiene* **6**: 265-279.

Bratthall, D. (1996): Dental caries: intervened-interrupted-interpreted. Concluding remarks and cariography. *European Journal of Oral Science* **104**, 486-491.

Buckley, L.A. (1981): The relationship between malocclusion, gingival inflammation, plaque and calculus. *Journal of Periodontology* **52**, 35-40.

Carlile, M.J. and Eaton, K.A. (2008): Tooth brushing behaviour in Europe: opportunities for dental public health. *International Dental Journal* **58 (Supp 1)**: 287-293.

Declerck, D., Leroy, R., Martens, L., Lesaffre, E., Garcia-Zattera, M.J., Vanden Broucke, S., Debyser, M. and Hoppenbrouwers, K. (2008): Factors associated with prevalence and severity of caries experience in preschool children. *Community Dentistry and Oral Epidemiology* **36**, 168-178.

Gábris, K., Márton, S. and Madléna, M. (2006): Prevalence of malocclusions in Hungarian adolescents. *European Journal of Orthodontics* **28**, 467-470.

Koch, R. (1994): Indikatoren für die Notwendigkeit kieferorthopädischer Behandlungsmaßnahmen. *Kieferorthopedie* **8**, 117-124.

Lange, D.E., Plagmann, H.C., Eenboom, A. and Promesberger, A. (1977): Klinische Bewertungsverfahren zur Objectivierung der Mundhygiene. *Deutsche Zahnarztliche Zeitschrift* **32**, 44-47.

Levin, K.A. and Currie, C. (2010): Adolescent toothbrushing and the home environment: sociodemographic factors, family relationships and mealtime routines and disorganisation. *Community Dentistry Oral Epidemiology* **38**: 10-18.

Marshall, T.A., Broffitt, B., Eichenberger-Gilmore, J., Warren, J.J., Cunningham, M.A. and Levy, S.M. (2005): The Roles of Meal, Snack, and Daily Total Food and Beverage. *Journal of Public Health Dentistry* **65**, 166-173.

Sogi, G.M. and Bhaskar, D.J. (2002): Dental caries and oral hygiene status of school children in Davangere related to their socio-economic levels: an epidemiological study. *Journal of Indian Society of Pedodontics and Preventive Dentistry* **4**, 152-157.

Stahl, F. and Grabowski, R. (2004): Malocclusion and caries prevalence: is there a connection in the primary and mixed dentitions? *Clinical Oral Investigations* **8**, 86-90.

Staufer, K. and Landmesser, H. (2004): Effects of crowding in the lower anterior segment - a risk evaluation depending upon the degree of crowding. *Journal of Orofacial Orthopedics* **65**, 13-25.

Wierzbicka, M. (2004): *Nationwide Monitoring of Oral Health Status and Its Conditioning of 2004*, Warsaw: Ministry of Health.

Wierzbicka, M. (2006): *Standard diagnosing of caries risk and prevention of dental caries in dental practice,* Warsaw:Foundation of Oral Health Promotion.

Wierzbicka, M., Petersen, P.E., Szatko, F., Dybizbanska, E. and Kalo, I. (2002): Changing oral health status and oral health behavior of schoolchildren in Poland. *Community Dental Health* **19**, 243-250.

World Health Organization (1997): *Oral Health Survey - basic Methods.* 4th ed. Geneva, WHO.