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Morphology of dentition in Polish children with trisomy 21 (Down syndrome)

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ABSTRACT This paper compares the dimensions and non-metric dental traits between Down syndrome patients (DS) and a control group. A total of 1,210 teeth of subjects with Down syndrome (diagnosed as regular trisomy 21 type) were analyzed. The mesiodistal (MD) and labiolingual or buccolingual (BL) diameters of each dental crown were measured, and the selected non-metric dental traits evaluated. The teeth of male and female DS patients were found to have lower values of both measurements compared to controls (excepting for the mesiodistal diameter of the lower mandibular premolar both in males and females). Sexual dimorphism of dental crown dimensions characteristic of contemporary human populations (the highest M-F difference was lower than 6%) was also observed: boys' teeth, particularly canines, are bigger than girls'(2.33 on average). Disorders in maxillary tooth alignment and the faint shoveling of upper central incisors (grade 1 according to ASU scale) were noted significantly more often among Down syndrome patients, but descriptive features correlating with dental crown size were observed more rarely (e.g., the distal accessory ridge on the upper canine and tuberculum Carabelli on the first molar).

KEY WORDS: metric dental traits, non-metric dental traits, odontology

Down syndrome (DS) was first described in 1866 and appears to result from regular trisomy of 21 chromosome in 95% of cases. It is most commonly caused by non-disjunction in the first meiotic division, and it usually (in approximately 80% of cases) appears as disomy in oocytes [Mikkelsen 1982]. Such disomies are the effect of considerable oocyte sensitivity to adverse physical and chemical factors that damage the cleavage spindle, which in turn disturbs the proper segregation of bivalents. Aberrations in oogenesis can be also induced by decreases in steroidal hormone levels and mitochondrial dysfunction [Goździcka-Józefiak *et al.* 2001]. Both phenomena progress with

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a woman's age, and, therefore, the frequency of DS prevalence (similar to trisomy 18 /Edwards' syndrome or trisomy 13 /Patau's syndrome) increases with maternal age.

In the remaining 5% of patients, this syndrome has been found to be associated with translocation of chromosome 13, 14, or 15 to chromosome 21 or 22, and also with a mosaic karyotype (where the proper cell lines of the 46,XX or 46,XY karyotype coexist together with the trisomy lines of 46,XX/47,XX+21 or 46,XY/46,XY+21). This additional chromosome 21, especially genes located inside the D21S55 region, are responsible for the occurrence of most developmental anomalies and differences in morphological structures of patients, including microcephaly, short stature, hypotonia, slanting palpebral fissures, a wide gap between the first and second toes, flat nasal bridge, brachycephaly, palmar crease, clinodactyly of the 5th finger, a large, protruding and furrowed tongue, malpositioned, dysplastic ears, Brushfield's spots, congenital heart defects, abnormal dermatoglyphics and mental retardation [Delabar *et al.* 1993, Korenberg *et al.* 1994, Madan *et al.* 2006]. Korenberg *et al.* [1994] proposed the chromosome 21 "phenotypic map" of 25 features associated with DS and suggests that DS is a contiguous gene syndrome.

In Poland, Rosiński [1992] carried out a comprehensive morphological analysis of Down syndrome patients based on a large number of cephalo- and somatometric features. He reported that statistically significant differences between the group studied and controls are related to length measurements (body height, lower extremity length, upper extremity length, hand length). Although these aberrations are observed in DS patients at all ages, there is a tendency for the retardation of their biological development to increase with time.

Among numerous studies on trisomy 21 in the world literature [e.g., Brugge *et al.* 1993, Nakamura & Tanaka 1998, Cosgrave *et al.* 1999, Royston *et al.* 1999, Bromhan *et al.* 2002, Hitzler *et al.* 2003, Mitchell *et al*. 2003] only a few reports have been concerned with the development and morphology of the dentition of Down syndrome patients [Prahl-Andersen & Oerlemans 1976; Barden 1980*c*; Townsend 1983*a*,*b*; Townsend & Brown 1983; Fisher-Brandies 1989; Bell *et al*. 2001; Keinan *et al*. 2006]. The evidence has demonstrated that disorders of ontogenetic development can also be reflected in the course of odontogenesis, which is the phenomenon of formation and eruption of the deciduous and permanent teeth. The delayed occurrence of both dentitions in Down syndrome patients (up to six months) can be explained by the general retardation and "imbalance" of developmental processes in DS subjects [Fisher-Brandies 1989; Jara *et al.* 1993]. An additional trend in the investigations on Down syndrome dentition involves the analysis of fluctuating asymmetry (FA) in particular tooth groups, which is a measure of the patient's so-called "developmental instability" [Barden 1980*a*,*b*; Townsend 1983*a*]. This is of special importance in the diagnosis of the discussed syndrome, which is characterized by high variability in the expression of pathological phenotypic features. Subjects with Down syndrome are distinguished by less-perfect mechanisms than observed in healthy people, which allow the organism to maintain homeostasis in spite of the negative influence of the outer environment that is responsible for the increase in FA level. Therefore, DS subjects have a more limited potential to "compensate" for disorders caused by environmental stress, meaning that the lower environmental stress can result in greater changes in the developmental path of such patients.

Although it is well known that dental measurements and non-metric dental traits differ between human populations, it is unknown if differences occur among Down syndrome patients representing different populations. The aim of the study was to analyze dental crown morphology (measurements and selected non-metric dental features) in Polish DS patients with regular trisomy 21.

Materials and Methods

The Down syndrome data were collected from 67 patients (30 males and 37 females), aged 9-17, who were treated at the Department of Pediatric Dentistry, Medical University of Łódź (central Poland). All patients represent one cytogenetic type (confirmed by cytogenetic tests) of Down syndrome – trisomy 21. Mosaic DS patients and translocation DS patients were excluded from this study. A total of 1,210 permanent teeth of DS patients were analyzed (Table 1). Data from the control group were collected from 60 students (30 males and 30 females), aged 17-23, with complete permanent dentition (males: M = 22.02 years, SD = 1.44; females: M = 22.28 years, SD = 1.10) who studied at the Medical University of Łódź. A total of 1,680 permanent teeth of the control group were analyzed. All DS and control subjects were of Polish ancestry living in central Poland. Both DS and control data collections were completed in the years 2003-2006.

Maxillary and mandibular standard models were constructed from alginate impressions of each patient. Models of the crowns of all completely erupted and intact permanent teeth (with the exception of third molars) were analyzed. All patients representing the control group had complete permanent dentition. In the case of any problems in achieving the proper maxillary or mandibular standard stomatological model, the procedure was repeated. The Down syndrome data were collected during a single medical examination (without any possibility of repeating the procedure for obtaining the proper alginate impressions). Over 20% of the DS patients had incomplete permanent dentition (effect of the delayed permanent dentition process, hypodontia and/or tooth extractions). Although the difference in the procedure for the gathering the DS and the control teeth created a possible sampling bias the amount of collected DS material was particularly scant.

Metric features of dental crowns

Tooth measurements were performed on dental casts by one investigator (EŻ) using calipers with a digital display (MAUa 150E2) and a technical accuracy of up to 0.03 mm. The mesiodistal (MD) and labiolingual or buccolingual (BL) crown diameters were determined for each tooth, according to standard procedure. The mesiodistal

Table 1. Number of analyzed teeth in DS group*

Tooth	Maxilla		Mandible	
	Males	Females	Males	Females
I1	48	60	42	60
I2	38	45	40	50
C	26	40	30	45
P1	40	35	40	50
P2	35	40	40	45
M1	45	58	45	50
M2	40	50	40	33
Total	272	328	277	333

* The Down syndrome data were collected from 30 male and 37 female patients, aged 9-17; if available, all the data for the right and left teeth were combined for this analysis (note that over 20% of the DS patients had incomplete permanent dentition).

length of the crown was defined as the greatest distance between the contact points of the approximal surface of the dental crown, with the calipers parallel to the occlusal and buccal surfaces. The buccolingual crown breadth was defined as the greatest distance between the buccal /labial and lingual surfaces of the crown, taken at right angles to the plane in which the mesiodistal diameter was taken [Hillson 1996]. The TEM and the index of reliability were calculated for each type of measurement [Ulijaszek & Lourie 1994]. Differences between the mean measurements in the DS and the control groups as well as between males and females were evaluated using the t-test. The significance level was chosen at $P < 0.05$ (the P level was calculated and provided for each tested difference).

Non-metric features of dental crowns

Non-metric dental crown variants were scored using the Arizona State University (ASU) dental anthropology system, which includes scoring forms as well as a series of corresponding reference plaques [Turner *et al.* 1991, Hillson 1996].

Eight non-metric dental traits were observed:

1) Diastema between the upper central incisors;
2) Crowding of the upper lateral incisors;
3) Rotation of the upper lateral incisors;
4) Shoveling of the upper central incisors – observed when the marginal ridges of the incisors are prominent and enclose a deep fossa in the lingual surface of the tooth;
5) Canine distal accessory ridge (DAR) on the lingual surface of the upper canines;
6) Carabelli cusp – the small additional cusp on the mesiolingual corner of the upper first molar presents in a variety of different forms;
7) Degree of reduction of the *hypoconus* on the first and second upper molars;
8) Number of cusps on the first and second lower molars.

The material was treated comprehensively, as insignificant differences were seen between the sexes in cases of non-metric dental traits. Distribution of variants of the non-metric features of teeth between the Down syndrome and control group were compared to those in the control group using the chi–square test.

Results

Metric features of dental crowns

A preliminary analysis showed no significant differences between the measurements of the right and the left teeth either in the DS or in the control subjects. Therefore, in each group the data for the right and for the left teeth were combined for analysis. Indices of reliability calculated for all dental dimensions exceeded 0.9625, which means that over 96% of the variability was caused by factors different than the mean measure error [Ulijaszek & Lourie 1994].

Both the mesiodistal (MD) and buccolingual (BL) crown diameters of all tooth groups except premolars in Down syndrome males and females were found to be smaller compared to controls (Tables 2-3). There were statistically significant differences between groups for all teeth with the exception of the upper second premolar (MD dimension) and the lower first incisor (BL dimension) in males as well as the lower first premolar (MD dimension) in females (Table 4). More pronounced differences were recorded for the BL measurements and the second teeth in the respective tooth groups (Figs. 1-4).

Table 2. The measurements of teeth [mm] – males

Tooth	Measurement	DS			Control			DS			Control		
		N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
		Maxilla						Mandible					
I1	MD	48	8.45	0.43	60	8.68	0.61	42	5.22	0.25	60	5.44	0.39
	BL		6.82	0.56		7.24	0.54		5.49	0.40		5.60	0.36
I2	MD	38	6.01	0.39	60	6.61	0.68	40	5.15	0.31	60	5.93	0.43
	BL		5.74	0.45		6.31	0.45		5.32	0.41		5.88	0.39
C	MD	26	6.77	0.46	60	7.78	0.72	30	6.20	0.32	60	6.76	0.54
	BL		6.25	0.51		8.09	0.65		6.39	0.39		7.43	0.63
P1	MD	40	6.28	0.52	60	6.73	0.52	40	7.12	0.45	60	6.92	0.53
	BL		7.80	0.56		9.34	0.71		7.15	0.62		7.61	0.76
P2	MD	35	6.57	0.37	60	6.49	0.50	40	7.18	0.46	60	6.97	0.52
	BL		8.12	0.43		9.34	0.72		7.41	0.67		8.13	0.81
M1	MD	45	9.75	0.48	60	10.52	0.92	45	9.82	0.52	60	11.20	0.83
	BL		10.25	0.54		11.41	0.86		9.41	0.76		10.18	0.92
M2	MD	40	8.44	0.54	60	9.70	0.85	40	9.35	0.68	60	10.46	0.79
	BL		9.75	0.65		11.08	0.91		9.28	0.83		9.80	0.81

Table 3. The measurements of teeth [mm] – females

Tooth	Measurement	DS			Control			DS			Control		
		N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
		Maxilla						Mandible					
I1	MD	60	8.27	0.54	60	8.54	0.67	60	5.05	0.32	60	5.30	0.43
	BL		6.78	0.56		6.86	0.55		5.29	0.39		5.59	0.43
I2	MD	45	5.90	0.39	60	6.47	0.63	50	4.98	0.30	60	5.87	0.35
	BL		5.51	0.46		6.08	0.46		5.22	0.40		5.69	0.45
C	MD	40	6.42	0.51	60	7.48	0.81	45	6.02	0.34	60	6.49	0.54
	BL		5.98	0.57		7.51	0.62		6.09	0.38		7.03	0.57
P1	MD	35	6.22	0.47	60	6.80	0.59	50	7.05	0.44	60	6.90	0.53
	BL		7.52	0.58		8.93	0.67		7.08	0.61		7.57	0.62
P2	MD	40	6.21	0.47	60	6.53	0.60	45	7.08	0.54	60	6.76	0.61
	BL		8.14	0.43		8.90	0.71		7.35	0.66		8.16	0.63
M1	MD	58	9.45	0.50	60	10.16	0.82	50	9.68	0.56	60	10.69	0.82
	BL		10.18	0.56		10.73	0.87		9.25	0.81		9.92	0.81
M2	MD	50	8.32	0.47	60	9.54	0.91	33	9.10	0.63	60	10.20	0.83
	BL		9.65	0.60		10.35	0.92		9.18	0.76		9.64	0.82

The phenomenon of sexual dimorphism, which is characteristic for human dentition, was observed in the analyzed DS sample. The MD diameter was significantly greater for the upper canine, for the upper second premolar and for the upper first molar as well as for the lower anterior teeth in DS males. The BL measurements of five teeth – upper second incisor, upper canine and the upper first premolar as well as the lower first incisor and the lower canine were greater in males than in females. The maxillary and mandibular canines were characterised by the highest percentage of sexual dimorphism, taking into account both measurements (Tabs. 5-6).

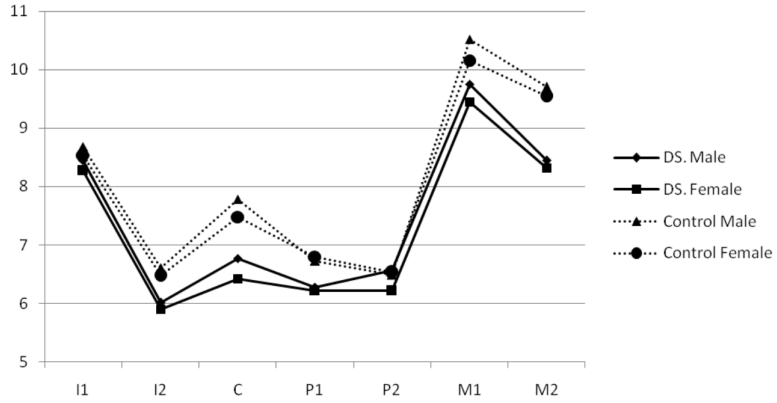

Fig. 1. Mesiodistal diameter of maxillary teeth [in mm].

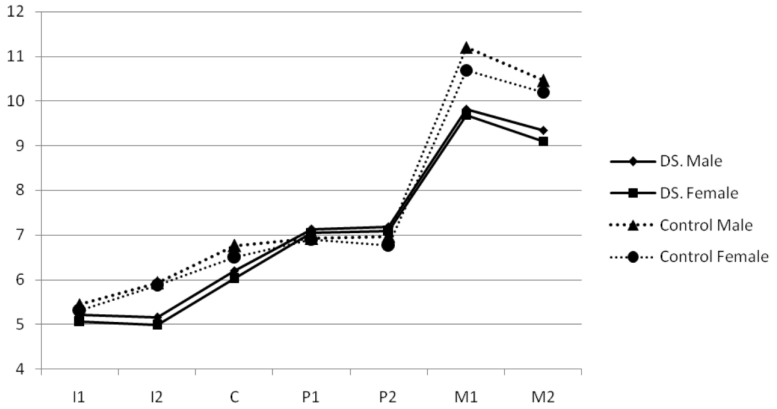

Fig. 2. Mesiodistal diameter of mandibular teeth [in mm].

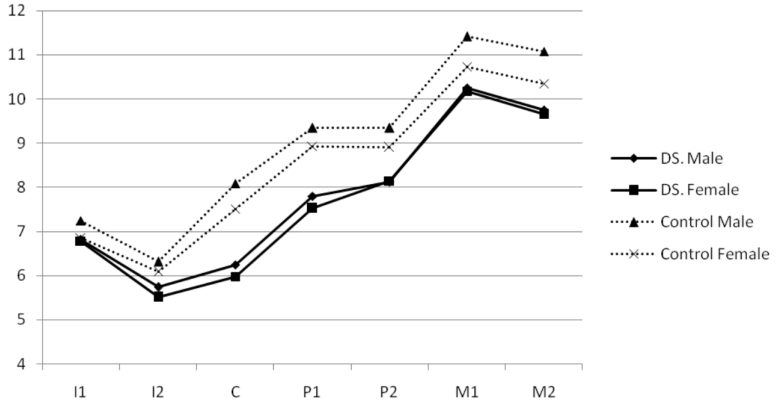

Fig. 3. Buccolingual diameter of maxillary teeth [in mm].

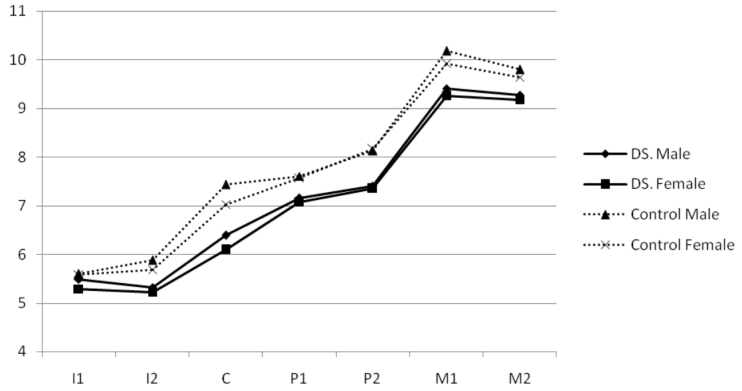

Fig. 4. Buccolingual diameter of mandibular teeth [in mm].

Table 4. T-test for differences in tooth measurements between DS and control group

Tooth	Measure-ments	Males		Females		Males		Females	
		t	p	t	p	t	p	t	p
		Maxilla				Mandible			
I1	MD	-2.19	0.03	-2.41	0.02	-3.19	0.00	-3.58	0.00
	BL	-3.91	0.00	-0.78	0.00	-1.44	0.15	-3.97	0.00
I2	MD	-4.90	0.00	-5.30	0.00	-9.79	0.00	-14.03	0.00
	BL	-6.05	0.00	-6.22	0.00	-6.82	0.00	-5.68	0.00
C	MD	-6.52	0.00	-7.29	0.00	-5.18	0.00	-5.08	0.00
	BL	-12.67	0.00	-12.36	0.00	-8.19	0.00	-9.49	0.00
P1	MD	-4.20	0.00	-4.92	0.00	1.94	0.06	1.58	0.12
	BL	-11.42	0.00	-10.28	0.00	-3.15	0.00	-4.12	0.00
P2	MD	0.82	0.42	-2.81	0.01	2.05	0.04	2.77	0.01
	BL	-9.02	0.00	-6.01	0.00	-4.61	0.00	-6.33	0.00
M1	MD	-5.07	0.00	-5.61	0.00	-9.71	0.00	-7.32	0.00
	BL	-7.87	0.00	-4.03	0.00	-4.52	0.00	-4.28	0.00
M2	MD	-8.24	0.00	-8.50	0.00	-7.11	0.00	-6.56	0.00
	BL	-7.90	0.00	-4.58	0.00	-3.08	0.00	-2.63	0.01

Table 5. Sexual dimorphism in MD diameter of permanent teeth in DS patients

	M-F*	M/F	t (M-F)	df	*p*	M-F*	M/F	t (M-F)	df	*p*
Tooth	Maxilla					Mandible				
I1	0.18	1.02	1.86	106	0.07	0.17	1.03	2.85	100	0.01
I2	0.11	1.02	1.26	81	0.21	0.17	1.03	2.60	88	0.01
C	0.35	1.05	2.79	64	0.01	0.18	1.03	2.27	73	0.03
P1	0.06	1.01	0.51	73	0.61	0.07	1.01	0.73	88	0.46
P2	0.36	1.06	3.60	73	0.00	0.10	1.01	0.90	83	0.40
M1	0.30	1.03	3.04	101	0.00	0.14	1.01	1.25	93	0.22
M2	0.12	1.01	1.11	88	0.27	0.25	1.03	1.59	71	0.12

* M-F – the absolute magnitude of sexual dimorphism (male measurement minus female measurement) [in mm]

Table 6. Sexual dimorphism in BL diameter of permanent teeth in DS patients

Tooth	M-F*	M/F	t (M-F)	df	*p*	M-F*	M/F	t (M-F)	df	*p*
	Maxilla					Mandible				
I1	0.04	1.01	0.37	106	0.72	0.20	1.04	2.50	100	0.01
I2	0.23	1.04	2.26	81	0.03	0.10	1.02	1.15	88	0.25
C	0.27	1.05	1.93	64	0.06	0.30	1.05	3.27	73	0.00
P1	0.28	1.04	2.10	73	0.04	0.07	1.01	0.53	88	0.60
P2	-0.02	1.00	-0.20	73	0.84	0.06	1.01	0.41	83	0.68
M1	0.07	1.01	0.63	101	0.53	0.16	1.02	0.98	93	0.33
M2	0.10	1.01	0.75	88	0.46	0.10	1.01	0.52	71	0.60

*M-F – the absolute magnitude of sexual dimorphism (male measurement minus female measurement) [in mm]

Non-metric features of dental crowns

Diastema between lower central incisors was observed more frequently in patients with Down syndrome than in healthy controls (Table 7). Also, crowding of the upper lateral incisors was more often recorded in DS patients than in controls. It must be emphasized that a rotation of the upper lateral incisors was evident in almost all patients with trisomy 21 (Table 7). The first and second degrees of shoveling of the central and lateral upper incisors were more often observed in the Polish DS group than in the control group (Table 8). A minimally formed distal accessory ridge appeared to be a characteristic feature of the upper canine in the DS group (Table 8).

Upon evaluation of the non-metric features of molars in the DS patients, a significant difference was noted in the frequency of Carabelli cusp occurrence on the upper first molar compared to the control group. This mesiolingual additional cusp in upper first molar occurred very rarely in the dentition of the studied Down syndrome individuals (18.45%) and exclusively in the form of a slightly pronounced groove (corresponding to grade 1 in the ASU scale)

Table 7. Frequency [%] of disorders in upper dental arch

Trait	DS $N = 67$	Control $N = 60$
Spacing between maxillary central incisors	25.37	21.67
Crowding between maxillary lateral incisors	91.04	8.33
Rotation of lateral incisors	97.01	6.67

Table 8. Frequency [%] of shoveling in upper central incisors and the distal accessory ridge in upper canine (according to ASU scale)

Upper I1 – shoveling			
	0	1	2
DS ($N = 108$)	69.44	27.78	2.78
Control ($N = 120$)	88.33	7.50	1.67
Upper C – distal accessory ridge			
	0	1	2
DS ($N = 108$)	95.45	4.55	0
Control ($N = 120$)	74.17	25.83	0

(Table 9). Although 51.67% of controls possessed a grade 2-5 Carabelli cusp (from pit to medium size cusp with attached apex making contact with lingual fissure), these were not observed in the Down syndrome patients.

A pronounced distolingual cusp – *hypoconus* (grades 5, 4, and 3 in the ASU scale) was a characteristic feature for most of the upper molars in the group of DS patients studied, and was found in over 91% of M1 and in almost 47% of M2 (Table 9). The lower molars of the DS patients usually had five cusps (Table 10) both on M1 and M2 (there were no six- or three-cusp first or second molar teeth).

All values of chi-square test for non-metric tooth variation between the DS and control group are presented in Table 11.

Table 9. Frequency [%] of non-metric dental traits of the upper molars: cusp of Carabelli and hypocone (according to ASU scale)

	M1 – Carabelli cusp					
	0	1	2	3	4	5-7
DS (N = 103)	81.55	18.45	0	0	0	0
Control (N = 120)	45.83	2.50	9.17	13.33	14.17	15.00
	M1 – Hypocone					
	0	1	2	3	4	5
DS (N = 103)	8.74	0	0	0	50.49	40.78
Control (N = 120)	0	0	0	0	90.83	9.17
	M2 – Hypocone					
	0	1	2	3	4	5
DS (N = 90)	26.67	21.11	16.67	0	36.67	10.00
Control (N = 120)	0	0	0	68.33	31.67	0

Table 10. Frequency [%] of cusps number on lower molars

	M1			
	6	5	4	3
DS (N = 95)	0	96.84	3.16	0
Control (N = 120)	0.95	80.83	19.17	0
	M2			
	6	5	4	3
DS (N = 73)	0	89.04	10.96	0
Control (N = 120)	0	4.17	93.33	2.13

Table 11. Chi-square test for non-metric tooth variation between DS and control group

Trait	χ^2	p
Spacing between Up. I1	0.26	0.49
Up. I2 – crowding	136.40	0.00
Up. I2 – rotation	141.12	0.00
Up. I1 – shovelling* (0 vs. 1-7)	11.13	0.00
Up. C – distal accessory rigde* (0 vs. 1-7)	18.76	0.00
Up. M1 – Carabelli cusp* (0 vs. 1-7)	73.77	0.00
Up. M1 – hypocone* (0-4 vs. 5)	49.68	0.00
Up. M2 – hypocone* (0-2 vs. 3-5)	101.14**	0.00
Lower M1 – cusp number* (6-5 vs. 4-3)	21.06	0.00
Lower M2 – cusp number* (6-5 vs. 4-3)	136.81	0.00

* ASU DPS – Arizona State University Dental Plaque System
** χ^2 with the Yates correction

Discussion

A reduction in tooth size has been observed in people with Down syndrome in the Australian population [Townsend 1983*a*,*b*, 1986; Brown & Townsend 1984] and attributed to the decreased cellular activity of developing tooth germs. As in all human populations, the second and third teeth in particular tooth groups are regarded as evolutionarily less "stable" and are subjected to stronger reduction [Hillson 1996, Türrp & Alt 1998]. When we consider both measurements of dental crowns, there is a diminished buccolingual diameter, which causes the teeth of children with Down syndrome to be less massive and more "delicate". Townsend and Brown [1983] have also reported the predominance of MD over BL in subjects with Down syndrome.

The analysis of the average differences between DS and control permanent teeth measurements provided results that were equivocal in relation to the hypothesis of Barden [1980*a*]. According to Barden, a greater difference should be observed for the late developing deciduous teeth, which is the effect of initial transitory acceleration in mitotic activity of enamel organs during early development followed by the generalized retardation in the growth characteristics of Down syndrome.

A number of studies have shown that the late developing teeth in DS individuals are the most severely affected for both deciduous and permanent dentition as well as for tooth diameters and tooth microstructures. Townsend [1983*b*] reported that in the primary dentition, anterior teeth tended to be larger and only the later developing second molars showed any reduction in size. Bell *et al*. [2001] found no significant differences in buccolingual diameters of enamel thickness between the DS and control primary incisors, although primary molars and permanent incisors showed reduction in enamel width [Keinan *et al*. 2006].

The reduction in tooth size seems to affect the frequency of occurrence of correlated, non-metric features, i.e., the frequency of the Carabelli cusp and the distal accessory ridge on the canine [Hillson 1996, Scott & Turner 1997]. According to Townsend and Brown [1983], the occurrence of a well-formed Carabelli cusp in a DS patient molars is rare, and it can be explained by either a slowing down of the cellular division activity in tooth germs during odontogenesis or by a secondary distortion of embryogenesis that results from metabolic abnormalities caused by a delay in placenta functioning [Mittwoch 1972, Paton *et al.* 1974]. In both cases, this is a consequence of general growth retardation (also observed in tooth germs) in Down syndrome children.

The sexual dimorphism of dental crown dimensions is slightly expressed and typical for contemporary living human populations. Numerous authors have reported a similar pattern of sexual dimorphism in study populations without genetic defects [e.g., Kaczmarek *et al.* 1988, Hattab *et al*. 1996, Hillson 1996].

The magnitude of the difference between teeth in the DS and in the control groups was on average from 5.78 to 12.76 %, and was most visible in the male buccolingual diameter of the upper teeth (Fig. 5). A similar "difference pattern" was observed by Townsend *et al*. [1988] for DS tooth measurements recorded from dental casts obtained from collections in Australia, New Zealand, Finland, Denmark and the USA (all DS subjects were of European ancestry) although the magnitude of the differences was greater (from 8.27 to 13.86%).

The developmental instability causes more visible and uneven growth of jaw

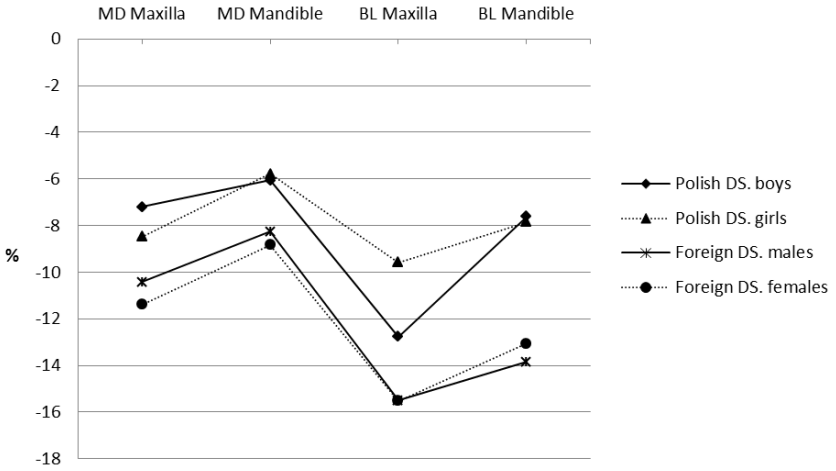

Fig. 5. The average magnitude of the difference [in percent] between teeth in the DS and control group. Comparative material – dental crown measurements of DS patients of European ancestry (foreign males and females) – taken from Townsend *et al*. [1988].

bones and teeth which can also explain disorders in dental arch tooth alignment, including the considerable increase in the frequency of rotation and crowding of the upper lateral incisors compared to the control group. At the same time, it is surprising that there is such a large group of DS patients with diastema between the upper central incisors when we consider the high frequency of crowding and tooth rotation. Numerous studies confirm that there is a reverse correlation between these features, and populations with an increased frequency of diastema are also characterized by a smaller number of disorders in tooth alignment in the jaws. It is likely that such a reversed correlation indicates the presence of irreversible homeoresis disorders within the masticatory system of the children studied.

Considering the morphology of the upper molars, it is important to note that despite the reduction in their size, both M1 and M2 generally have the four-cusp structure with a distinctly formed *hypoconus*.

Lower molars are usually five-cusped or four-cusped. The additional distal cusp (cusp 6) was not observed and the distobuccal cusp (cusp 5) was reduced in almost all DS patients. The distal region of the mandibular molars (a later forming crown region) is more likely to be affected by the growth retardation of trisomy 21 [Brown & Townsend 1984]. These findings are supported by Peretz *et al*. [1998], who analyzed the inter-cusp distances and the areas of the pentagon of the permanent mandibular first molars of DS subjects. Peretz *et al*. [1998] found significantly smaller D-MB-DL (distal-mesiobuccal-distolingual) and MB-DL-D angles as well as a higher MB-D-DL angle in DS subjects, which means that teeth of the DS individuals were characterized by distal and distolingual cusps located closer to the centre of the tooth. Such a "pattern" of the inter-cusp distances reduction seems to confirm the hypothesis that in DS individuals, the change in size in the mandibular molars occurs at an early stage, while the change in shape occurs at a later stage

of tooth formation reflecting the accumulated effects of continued growth retardation [Nery *et al*. 1975, Peretz *et al.* 1996]. It is interesting that in a high percentage of the subjects, a slightly pronounced shoveling (grade 1 according to the ASU system) on the first upper incisors was noticed. This feature is observed primarily among people of Asiatic ancestry and among archaic human populations, and it is considered to be an accurate, genetic adaptation to carnivorousness in severe and cold climates [Mizoguchi 1985]. Although there was an increased frequency of this feature in the patients studied, it is difficult to explain. It would be interesting to study this phenomenon among Down syndrome patients who belong to different contemporary human populations or among DS people who represent another DS type (mosaic and translocation type of DS). Such a comparison could also be helpful in explaining both the mechanism of odontogenesis and the role of the superoxide dismutase metabolism pathway in this process.

Final remarks

The data demonstrate that when compared to controls, the teeth of Polish people with regular trisomy 21 are characterized by:

1. Significantly smaller dimensions of the mesiodistal and buccolingual crown diameters compared to controls (average difference from 5.78 to 12.76%).

2. Considerable reductions of the BL measurement (observed primarily in the maxilla), which results in less-massive and more-delicate teeth.

3. Slightly expressed sexual dimorphism of the measured features – males' teeth are on average 2.33% larger than those of females, and canines present the highest percentage of dimorphism (4.25% – upper canine, 3.80% – lower canine).

4. Higher frequency of tooth alignment disorders in the jaw, including crowding and rotation of the upper lateral incisors and a higher frequency of slightly expressed shoveling of the upper incisors.

5. Minimally developed features that correlate with the sizes of the upper teeth, such as the Carabelli cusp on the molar and the distal accessory ridge on the canine.

Notes

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Streszczenie

Celem pracy była analiza morfologii koron zębowych (zarówno cech metrycznych, jak i niemetrycznych) pacjentów z trisomią 21 pary chromosomów reprezentujących populację polską. Materiał badawczy stanowiły gipsowe odlewy szczęki i żuchwy 67 dzieci w wieku 9-17 lat (30 chłopców i 37 dziewcząt) – pacjentów Zakładu Stomatologii Wieku Rozwojowego Uniwersytetu Medycznego w Łodzi obarczonych zespołem Downa. Wszyscy chorzy reprezentowali jeden typ cytogenetyczny (potwierdzony testami genetycznymi) – regularną trisomię chromosomu 21. Łącznie analizie poddano 1210 koron zębów stałych osób z zespołem Downa (Tab. 1). Materiał porównawczy stanowiły gipsowe odlewy szczęki i żuchwy 60 studentów (30 mężczyzn i 30 kobiet) Uniwersytetu Medycznego w Łodzi. Łącznie w grupie kontrolnej znalazło się 1680 koron zębów. Wszystkie zęby prawej i lewej strony włączane były do analiz.

Pomiary zębów były dokonywane po obu stronach szczęki przy użyciu dontometru o odczycie cyfrowym (MAUa 150 E2) z dokładnością do 0,03 mm. Dla każdego zęba wykonano standardowo pomiar przyśrodkowo-dalszy (MD) i wargowo-językowy lub policzkowo-językowy (BL) korony. Różnice pomiędzy średnimi pomiarami w porównywanych grupach testowano testem t-Studenta. Przy analizie cech odontoskopijnych posługiwano się standardowymi skalami ASU DPS (Arizona State University Dental Plaque System). Obserwowano częstość występowania wariantów ośmiu cech niemetrycznych: diastemy pomiędzy górnymi siekaczami przyśrodkowymi, stłoczeń i rotacji górnych siekaczy bocznych, szufelkowatości górnych siekaczy przyśrodkowych, dodatkowego brzegu szkliwnego na zewnętrznej krawędzi górnego kła, dodatkowego guzka na przyśrodkowo-językowej powierzchni górnego pierwszego zęba trzonowego (*tuberculum Carabelli*), stopnia redukcji hypokonusa na pierwszym i drugim zębie trzonowym szczęki, liczby guzków na pierwszym i drugim zębie trzonowym żuchwy. Rozkłady wariantów analizowanych cech odontoskopijnych w porównywanych grupach testowano przy pomocy testu chi-kwadrat.

Zęby badanych pacjentów z regularną trisomią 21 pary chromosomów w porównaniu z populacją kontrolną charakteryzują się: mniejszymi wymiarami przyśrodkowo-dalszymi

i wargowo-językowymi koron (przeciętna różnica wahała się od 5,78 do 12,76%) (Tab. 2-4), znaczniejszą redukcją pomiaru BL (Ryc. 1-5), nieznacznym dymorfizmem płciowym cech metrycznych koron (osiągającym przeciętnie 2,33%) (Tab. 5-6), większą częstością zaburzeń ustawienia zębów w szczękach (Tab. 7), minimalnie wykształconymi cechami korelującymi z rozmiarami zębów górnych – guzkiem Carabelliego na pierwszym trzonowcu i dodatkowym brzegiem szkliwnym na zewnętrznej krawędzi kła (Tab. 8-9), znaczniejszą redukcją liczby guzków na dolnych zębach trzonowych (Tab.10). Rozkłady wariantów wszystkich analizowanych cech odontoskopijnych (z wyjątkiem diastemy pomiędzy przyśrodkowymi siekaczami szczęki) istotnie różniły polskich pacjentów z zespołem Downa od grupy kontrolnej (Tab. 11).