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Craniofacial morphology and its relation to the eruption pattern of permanent teeth in the supporting zone of the dentition in a group of Romanian children in Timişoara

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Abstract

The purpose of this study is to determine the cephalic and facial morphological typology in prepubertal children from Timişoara (Romania) and to develop a population-specific reference for the dental eruption of permanent teeth in the supporting zone of the dentition, in relation to the facial morphological typology. Using cephalic and facial indexes in a group of 234 preadolescents with mixed dentition, we quantified morphological associations between cephalic and facial types, using a cross-sectional design. The prepubertal children in Timişoara have a dominant mesoprosopic facial type and mesocephalic type. For supporting zone of the dentition, the presence of permanent teeth, the canine, the first premolar and the second premolar was recorded, for all four quadrants. Dental eruption in the supporting zone of the dentition has particularities depending on population group, gender, dental arch, but also facial type. From the data of this study, the following patterns of eruption, specific to each facial type, have resulted: for leptoprosopic facial type – first upper premolar (UP1), second upper premolar (UP2), upper canine (UC)/first lower premolar (LP1), lower canine (LC), second lower premolar (LP2); for mesoprosopic facial type – UP1, UP2, UC/LC, LP1, LP2; and for euryprosopic facial type – UP1, UP2, UC/LC, LP1, LP2. The leptoprosopic and euryprosopic facial types have a delayed and accelerated eruption compared to the mesoprosopic facial type. The euryprosopic facial type has more intense mandibular eruption. The leptoprosopic facial type registers the largest percentage of children requiring orthodontic treatment. Monitoring the sequence of eruption of the permanent teeth is very important to ensure the balanced development of the dental occlusion, mandible and facies as a whole.

Keywords: permanent teeth, sequence eruption, supporting zone, cephalic morphology, facial morphology.

Introduction

Craniofacial morphological characteristics vary both racially and interracially, from one geographic region to another [1]. In order to establish in-group interracial morphological standards, data were collected from various population groups: metrics, craniofacial indices – to express the ratio of landmarks of one distance to another distance in an individual.

The cephalic index and the facial index allow the establishment of quantitative measures in the definition of the human cranial and facial morphological typology, eliminating the degree of subjectivity in estimation [2]. The association of cephalic morphological types with the facial ones, the way they are related, is still not completely understood [3, 4]. The postnatal development of the skull and facial bones takes place at different times and in different proportions. The facial skeleton has a longer evolution, and will be influenced more by functional and environmental factors. As the child is in process of growing, the profile of facial growth occurs at the bottom of the face (the face's "dental", "masticatory" side) [5].

According to Izard [6], the prepubertal period is the last and most intense period of three-dimensional facial growth, during which the definitive morphological type of the face is determined. At intraoral level, this period is characterized by the existence of mixed dentition, the replacement of the deciduous teeth with the permanent teeth, and the establishment of occlusal relationship. During the transition from deciduous to permanent teeth, the most common problems appear in the supporting zone of the dentition, the part from the maxillary or mandibular arch where the deciduous canines and molars are positioned [7]. Usually, the width of the deciduous teeth is bigger than the mesiodistal diameter of the permanent teeth resulting in a "spare" space for the eruption of the permanent teeth, called a Leeway space. A wide range of situations may result in the loss of this space for eruption, unbalancing the occlusal relationships, the mandibular morphological development [8], and ultimately the facial development. To act interventional or to wait become key issues for the physician.

The identification of craniofacial, racial and group morphological characteristics allows an increase in

the accuracy of diagnosis of growth and development abnormalities in children, the course of the medical treatment, the orthodontic and orthopedic treatment, the craniofacial reconstructive treatment, it can be useful in forensic medicine and in anthropological studies, and last but not least, it can provide elements that can contribute to improving risk management in the development of national and local orthodontic health programs for children.

The purpose of this study was:

▪ To determine the cephalic and facial morphological typology in prepubertal children from Timişoara (Romania);

▪ To develop a population-specific reference for the dental eruption of permanent teeth in the supporting zone of the dentition in relation to the facial morphological typology.

Participants, Materials and Methods

An analytical cross-sectional study was conducted on 234 children aged 8 (90 to 102 months), 9 (103 to 114 months), 10 (115 to 126 months) and 11 (127 to 138 months). The participants were selected from the children attending the Specialized Outpatient Facility of the Timişoara Maxillofacial Surgery Clinic, through the monitoring and control program of the oral health of the population of Timişoara, carried out after the finalization of the Project financed by the European Regional Development Fund: "Rehabilitation, modernization, development and equipping of the Outpatient Facility of the Maxillofacial Surgery Clinic within the Municipal Clinical Emergency Hospital of Timişoara".

The study was approved by the Ethics Committee of the Municipal Clinical Emergency Hospital of Timişoara. The informed consent of the parents was obtained for all participants in the study. The study was conducted between January 2017 and June 2017.

The study sample selected may be considered representative both quantitatively and qualitatively for the population of Timişoara, because it was composed of children from all areas of the city, and from various social groups.

The selection criteria for the participants were:

▪ Inclusion criteria: all dental records of healthy children aged between 8 and 11 years old, who came in for consultations in the Timişoara Maxillofacial Surgery Clinic, cooperating children, informed consent of the parents.

▪ Exclusion criteria: children with systemic diseases that may have influenced tooth eruption, children with genetic, traumatic or other craniofacial malformation, children under dental–facial orthodontic and orthopedic treatment.

The following information was recorded: gender, date of birth, date of consultation.

The cephalometric examination was performed by a single examiner, at the same diurnal interval, by the direct method. The measurement of craniofacial parameters using the techniques of Martin & Saller (1957) [2] was performed on each subject with a digital caliper, with an accuracy of 0.01 mm (Boss, Hamburg, Germany). The head of the subject was allowed to rest in the eye-ear plane or Frankfurt plane, with the tragion and right orbitale in the same plane. Subjects were sat on low-rise stool and were not allowed to change their position while taking the measurements.

Head dimensions were measured: head length [glabella (G) to opisthocranion (Op)], head breadth [euryon (Eu) to euryon], facial length [nasion (N) to gnathion (Gn)], facial width (distance between the two zygomatic (Zy) landmarks), lower jaw breadth (gonion to gonion).

Based on these parameters, the cephalic index (CI) and facial index (FI) were calculated according to the formulae: $CI = (Eu–Eu)\times100/(G–Op)$, $FI = (N–Gn)\times100/(Zy–Zy)$. The cephalic and facial typology was established in accordance with the Martin & Saller (1957) classification, without using the classification's subcategories to facilitate subsequent comparative determinations.

The endo-oral clinical examination was performed by a single examiner in a dental chair, with the help of a mouth mirror, probe, and William's probe, which was used to determine the overjet and overbite.

The following were recorded:

▪ The presence of (erupted) permanent canines and premolars, type of tooth. These teeth were recorded as upper canine (UC), first upper premolar (UP1), second upper premolar (UP2), lower canine (LC), first lower premolar (LP1), second lower premolar (LP2). An erupted tooth was defined as a tooth penetrating the gingiva and becoming visible in the oral cavity.

▪ Parameters of Dental Aesthetic Index (DAI): overjet, underjet, missing teeth, diastema, anterior open bite, anterior crowding, anterior spacing, largest anterior irregularity (mandible and maxilla), anterior–posterior molar relationship.

DAI was computed [9]. DAI was adopted as a cross-cultural index by the *World Health Organization* (WHO) for *The International Collaborative Study of Oral Health Outcomes* (ICS II).

A Microsoft Excel spreadsheet was used for creating the database. For numerical variables, descriptive summary measures of central tendency were computed. For ordinal or nominal variables, and frequency (%/N) of the study variables were computed. When analyzing the resulting data, the variables taken into account were cephalic and facial indexes, the presence of permanent canine, first and second premolars in all quadrants, DAI which was further used to quantify the orthodontic treatment need.

Results

The children's distribution was fairly balanced in terms of gender, with a slight preponderance of boys, 51.48%, compared to girls 48.51%.

Cephalometric examination

From the cephalic index values, the predominant cranial type in children is the mesocephalic type (62.39%), followed by the dolichocephalic type (25.21%), and the brachycephalic type (12.4%).

Gender analysis reveals that this trend is maintained.

The dolichocephalic type is better represented in boys, and the brachycephalic type is encountered in a similar proportion in both genders (Table 1).

From the facial index values, the prevailing facial type in children is the mesoprosopic (M) type (66.24%), followed by the leptoprosopic (L) type (26.92%), and the euryprosopic (E) type (6.84%).

This trend in maintained by genders. The leptoprosopic and euryprosopic facial types are more prevalent in males than in females (Table 2).

The most common associations are: the mesocephalic cranial type with mesoprosopic facial type (77.39%), brachycephalic with mesoprosopic (75.86%), and dolichocephalic with leptoprosopic (66.1%).

The frequency of these associations is preserved in females: mesocephalic cranial type with mesoprosopic facial type (80.28%), brachycephalic with mesoprosopic (71.42%), dolichocephalic with leptoprosopic (64%).

In the order of frequency, males associate: brachycephalic cranial type with mesoprosopic facial type (80%), mesocephalic with mesoprosopic (74.66%), and dolichocephalic with leptoprosopic (67.64%) (Table 3).

Table 1 – ***Cephalic index: percentage in males and females***

Head types	Males			Females			Total	
	Range of index	*No.*	*%*	*Range of index*	*No.*	*%*	*No.*	*%*
Dolichocephalic	*x*–75.9	34	27.42	*x*–76.9	25	22.73	59	25.21
Mesocephalic	76–80.9	75	60.48	77–81.9	71	64.54	146	62.39
Brachycephalic	81–*x*	15	12.1	82–*x*	14	12.73	29	12.4
Total		124	100		110	100	234	100

Table 2 – ***Facial index: percentage in males and females***

Facial types	Males			Females			Total	
	Range of index	*No.*	*%*	*Range of index*	*No.*	*%*	*No.*	*%*
Euryprosopic	*x*–83.9	9	7.25	*x*–80.9	7	6.36	16	6.84
Mesoprosopic	84–87.9	79	63.71	81–84.9	76	69.09	155	66.24
Leptoprosopic	88–*x*	36	29.04	85–*x*	27	24.55	63	26.92
Total		124	100		110	100	234	100

Table 3 – ***Correlation between morphological facial types with morphological cephalic types***

Morphological facial types				Cephalic index categories					
				Brachycephalic		*Dolichocephalic*		*Mesocephalic*	
				N%	*Count*	*N%*	*Count*	*N%*	*Count*
Gender	Males	Facial index categories	*Euryprosopic*	20	3	0	0	8	6
			Leptoprosopic	0	0	67.64	23	16	12
			Mesoprosopic	80	12	29.41	10	74.66	56
	Females	Facial index categories	*Euryprosopic*	28.57	4	0	0	2.81	2
			Leptoprosopic	0	0	64	16	18.3	13
			Mesoprosopic	71.42	10	40	10	80.28	57
Total		Facial index categories	*Euryprosopic*	24.13	7	0	0	5.47	8
			Leptoprosopic	0	0	66.1	39	17.12	25
			Mesoprosopic	75.86	22	33.89	20	77.39	113

The width of the mandible relative to the width of the face shows a transverse development of the mandible inferior to the transverse development of the face. The proportion of the mandible width of the face width is, on average, at age of 8 of 80.15%, and at age of 11 of 79.6%.

Endo-oral examination

All subjects presented all first permanent molars and permanent incisors erupted.

The eruption of the permanent teeth in the supporting zone of the dentition has dental arch – but also gender-related characteristics (Table 4 related with Figures 1–5).

On the maxilla:

▪ Both genders have the following order of eruption: 1st premolar, 2nd premolar, canine (Figures 1 and 2);

▪ The percentage of teeth erupted in the supporting zone of the dentition is higher for males.

On the mandible:

▪ In girls, teeth erupt in the order they are placed on the dental arch (Figure 1);

▪ In boys, the order is: 1st premolar, canine, 2nd premolar (Figure 2);

▪ The percentage of teeth erupted in the supporting zone of the dentition is higher for females.

In the entire oral cavity, the studied dental group exhibits an eruptive advance in females. At age of 11, the eruption proportion is approximately equal by genders.

On all subjects, the eruption sequence in the supporting area of the dentition is UP1, UP2, UC/LP1, LC, LP2 (LP1 and LC almost simultaneously).

Upper permanent canines and premolars erupt earlier in the mesoprosopic facial type. At the age of 9, the rhythm of the upper maxilla eruption increases. The euryprosopic facial type has a late but accelerated eruption, with a higher degree of eruption at age of 11 than the mesoprosopic facial type. At age of 11, the leptoprosopic facial type presents the highest degree of eruption.

The teeth eruption pattern in the upper maxilla in the supporting area of the dentition for all facial types is UP1, UP2, C (Figure 3).

For the mesoprosopic facial type, the dental group permanent canine–premolars in the mandible erupts earlier than in the other facial types. At age of 9, the rhythm of the eruption intensifies especially in the leptoprosopic and euryprosopic facial types. At age of 11, the euryprosopic facial type has the largest percentage of teeth erupted in the supporting zone of the dentition. In order of degree of eruption, the leptoprosopic and mesoprosopic types follow.

Table 4 – ***Dynamics of the permanent teeth eruption in the supporting zone of the dentition***

Type of tooth	Gender	Age [years]			
		8	*9*	*10*	*11*
Upper maxilla					
%UC	*Boys*	3.57	4.9	20.37	48.43
	Girls	0	3	43.93	55.88
	B and G	2.08	3.96	33.33	51.02
%UP1	*Boys*	17.85	30.39	64.81	84.37
	Girls	20	33.65	72.72	70.58
	B and G	18.75	38.61	70	79.59
%UP2	*Boys*	7.14	8.82	53.7	54.68
	Girls	5	12.5	46.96	58.82
	B and G	6.25	21.78	50	56.12
%Overall	*Boys*	9.52	14.7	46.29	62.5
	Girls	8.33	13.66	55.05	61.76
Lower maxilla					
%LC	*Boys*	3.57	10.14	50	79.68
	Girls	15	25	80.3	91.17
	B and G	8.33	17.82	65.83	81.63
%LP1	*Boys*	7.14	15.68	62.96	82.81
	Girls	10	24	71.21	82.35
	B and G	8.33	17.82	67.5	84.69
%LP2	*Boys*	0	7.84	44.44	46.87
	Girls	5	9	33.33	38.23
	B and G	2.08	8.41	38.33	43.87
%Overall	*Boys*	3.57	12.74	52.46	69.79
	Girls	7.14	19.33	61.61	70.58
Maxillae and mandible					
%C	*Boys*	3.57	9.31	34.25	64.06
	Girls	7.5	14	62.12	73.52
%P1	*Boys*	12.5	28.92	63.88	83.59
	Girls	15	29.5	72.72	76.47
%P2	*Boys*	3.57	8.33	49.07	51.56
	Girls	5	11	40.15	48.52
%Overall	*Boys*	6.54	15.52	49.38	66.92
	Girls	9.16	18.16	58.33	66.17

UC: Upper canine; UP1: First upper premolar; UP2: Second upper premolar; LC: Lower canine; LP1: First lower premolar; LP2: Second lower premolar; C: Canine; P1: First premolar; P2: Second premolar; B: Boys; G: Girls.

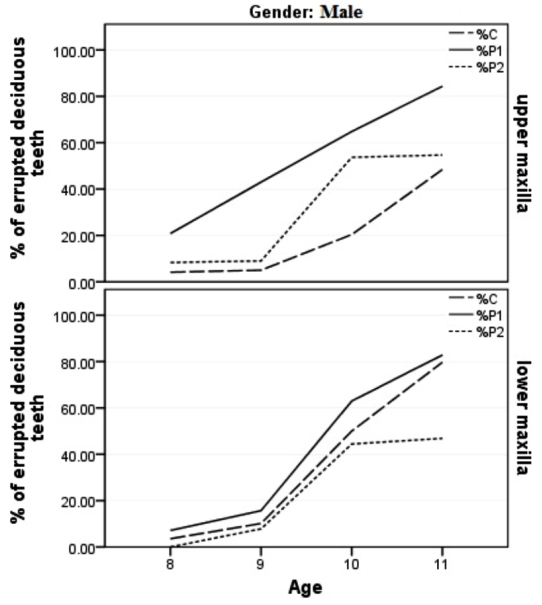

Figure 1 – ***Dynamics of the permanent teeth eruption in the supporting zone of the dentition in boys. C: Canine; P1: First premolar; P2: Second premolar.***

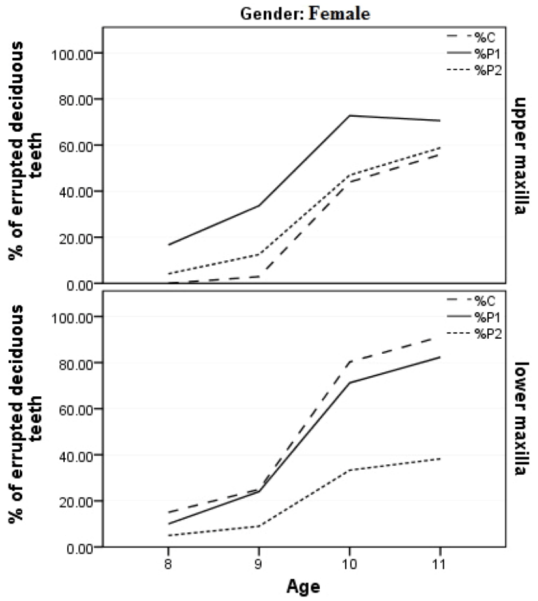

Figure 2 – ***Dynamics of the permanent teeth eruption in the supporting zone of the dentition in girls. C: Canine; P1: First premolar; P2: Second premolar.***

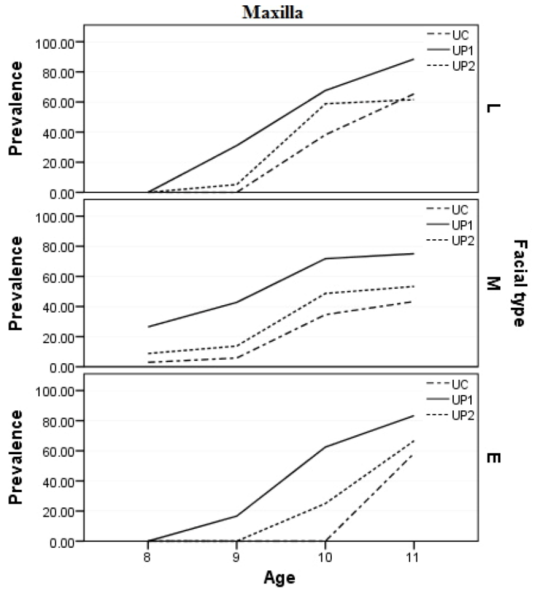

Figure 3 – ***Correlation of permanent teeth eruption in the supporting zone of the dentition with facial types in maxilla. UC: Upper canine; UP1: First upper premolar; UP2: Second upper premolar; L: Leptoprosopic; M: Mesoprosopic; E: Euryprosopic.***

The teeth eruption pattern in the mandible depending on the facial type is: leptoprosopic: LP1, LC, LP2, mesoprosopic: LC, LP1, LP2, euryprosopic: LC, LP1, LP2 (Figure 4).

The acceleration of the rate of teeth eruption in the supporting zone of the dentition at age of 9 is greater for the leptoprosopic and euryprosopic facial types. At age of 11, the euryprosopic facial type has the most advanced degree of eruption, and the mesoprosopic facial type has a degree of eruption inferior to other facial types (Figure 5).

The leptoprosopic facial type registers the largest percentage of children requiring orthodontic treatment (76.46% at age of 10, and 38.46% at age of 11). At age of 11, the mesoprosopic facial type features the lowest percentage of dental occlusion impairment (Table 5).

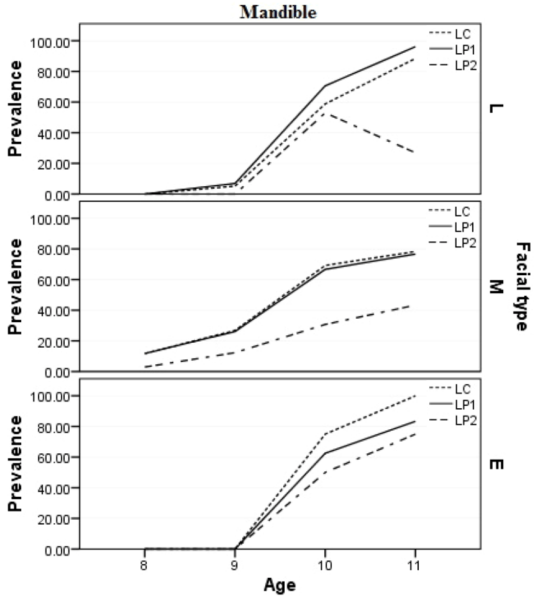

Figure 4 – ***Correlation of permanent teeth eruption in the supporting zone of the dentition with facial types in mandible. LC: Lower canine; LP1: First lower premolar; LP2: Second lower premolar; L: Leptoprosopic; M: Mesoprosopic; E: Euryprosopic.***

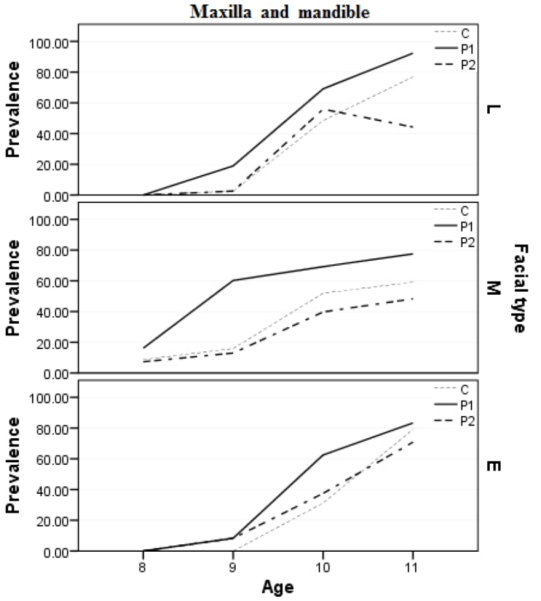

Figure 5 – ***Correlation of permanent teeth eruption in the supporting zone of the dentition with facial types in maxilla and mandible. C: Canine; P1: First premolar; P2: Second premolar; L: Leptoprosopic; M: Mesoprosopic; E: Euryprosopic.***

Table 5 – ***The need for orthodontic treatment according to DAI values after the first period of mixed dentition (by ages and facial types)***

Range of DAI	Case sensitive level and relative treatment need	Leptoprosopic [%]		Mesoprosopic [%]		Euryprosopic [%]	
		10 years	*11 years*	*10 years*	*11 years*	*10 years*	*11 years*
13–25	Normal or minor malocclusion; no treatment need or slight need	23.52	61.53	74.35	93.33	100	83.33
26–30	Definite malocclusion; treatment elective	58.82	38.46	20.51	6.66	0	16.66
31–35	Severe malocclusion; treatment highly desirable	11.76	0	2.56	0	0	0
36 and higher	Very severe (handicapping) malocclusion; treatment mandatory	5.88	0	2.56	0	0	0
	Overall treatment need [%]	76.46	38.46	25.63	6.66	0	16.66

DAI: Dental Aesthetic Index.

Discussions

The assessment of the craniofacial morphology was performed on three directions of examination: cranial, facial and intraoral. We have chosen to capitalize on index metrics, as the use of value ranges reduces sources of error and facilitates comparative study.

At regional level, adjacent to the southwestern area of Romania, studies reveal the presence of a facial and cranial morphological typology variability: in Vojvodina (Serbia), the mesoprosopic facial type predominates in ethnic Hungarians [10], the central region of Serbia is dominated by the facial leptoprosopic type [11], the Albanian population in Kosovo primarily displays the hyper-leptoprosopic type and the brachycephalic cranial type [12], while the dolichocephalic cranial type and the mesoprosopic facial type predominate in the Croatian population [13].

The dominant cephalic phenotype in the prepubertal children of Timişoara is mesocephalic. The result obtained is consistent with the anthropological research results according to which the predominant cephalic type in Eastern and Central Europe and Russia is the mesocephalic type [14, 15].

The dominant facial phenotype in the examined subjects is the mesoprosopic one.

The study revealed a varied combination of cephalic and facial types. The combinations dolichocephalic with euryprosopic and brachycephalic with leptoprosopic were not recorded. The analysis of the relationship between the cephalic and facial types provides data that is consistent with the concept that the facial growth pattern is influenced by the shape of the head, the base of the skull being the stable structure from which the face develops in the anterior and inferior directions [16].

Among the factors that influence the normal development of the craniofacial complex is also the physiological process of eruption of permanent teeth [17]. Any incongruity tolerated after the lateral incisor eruption may be considered an abnormality due to constitution [18] risking the development of a malocclusion and the disruption of the development of the maxillofacial complex.

The temporal analysis of the proportion of transversal development of the mandible related to the face, being approximately constant, shows a balanced growth. Functional influences did not produce significant changes in the dimensions of the studied age group.

Monitoring the sequence of eruption of the permanent teeth is very important since if some modifications are noticed, the specialist can treat the situations and prevent the occurrence of complications [19].

From the data of this study, the following patterns of eruption, specific to each gender, have resulted:

- Boys: UP1, UP2, UC/LP1, LC, LP2;
- Girls: UP1, UP2, UC/LC, LP1, LP2.

This sequence is the same as that reported in the Jordan (2012) trial [20]. Other studies report eruption patterns specific for males – study in Lithuania (2012) [21], Turkey (2015) [22], or females – study in Croatia (2000) [23]. Most existing studies [24, 25] argue that girls are more advanced in permanent teeth development and emergence time than boys. The data collected by us show that females have an advance of the proportion of the permanent canine–premolar dental group eruption in the mandible and globally, in both jaws.

In the maxilla, the eruption sequence of the permanent canine–premolar dental group does not vary depending on the subjects' gender.

According to Zarnea (1993), more than 18 variants of the dental eruption sequences are described in the literature [26]. According to Massler & Schour (1941) [27], Okuya (1950) [28], and Lo & Moyers (1953) [29], the following sequences exist:

- Type I: UP1, UC, UP2/LC, LP1, LP2;
- Type II: UP1, UP2, UC/LC, LP1, LP2.

The results of this study UP1, UP2, UC/LP1, LC, LP2 (LP1 and LC almost simultaneously) are approaching the 2nd eruption pattern. They are consistent with the results of a study conducted in Bucharest, Romania [30].

To the best of our knowledge, the determination of the eruption sequence by facial types has never been studied before. The determined patterns are: the leptoprosopic facial type: UP1, UP2, UC/LP1, LC, LP2, the mesoprosopic facial type UP1, UP2, UC/LC, LP1, LP2, the euryprosopic facial type: UP1, UP2, UC/LC, LP1, LP2.

The leptoprosopic and euryprosopic facial types have a delayed and accelerated eruption compared to the mesoprosopic facial type. If for the leptoprosopic facial type the dental eruption time in the supporting zone of the dentition is similar for the two jaws, the euryprosopic facial type has a faster, more intense mandibular eruption. These considerations alter the time available for dental–facial orthodontic and orthopedic surgery.

To analyze the extent to which facial typology is related to dental malocclusion, the DAI analysis was used. Severe and very severe malocclusions were recorded in the leptoprosopic facial type, followed by the mesoprosopic facial type. The severe and very severe types of malocclusion were recorded in the age of 10 group, and did not appear in the age of 11 group. This may be explained by a large loss of the dental eruption space at age of 10, an effect of both premature loss and caries experience in primary teeth. Another explanation could be aimed at the age of 11 group for which the growth and development of the jaws partly compensated for the loss of the eruption space, or the subjects had benefited from more effective dental and dental–maxillary treatments in the past, which together with the growth process led to the demotion of cases to the category of "definite malocclusion; treatment elective". The study excluded children undergoing orthodontic treatment but there was no record of previous interceptive orthodontic treatments, this being a limitation of the study. The second limitation is that the effect of both the premature loss and caries experience in primary teeth could not be evaluated in this cross-sectional study. A relationship of this type could have been analyzed through a longitudinal study. Longitudinal designs have limitations in high time and resources consumption or in loss of follow-up of patients. In contrast, cross-sectional studies are simpler to carry out, can cover a large sample of subjects with fewer costs and efforts, are reliable, and can be used at the time of tooth emergence [31].

Conclusions

The prepubertal children in Timişoara have a dominant craniofacial morphological characteristics mesocephalic type and mesoprosopic facial type. The relationship between the cephalic type and the facial type is balanced. Dental eruption in the supporting zone of the dentition has particularities depending on: population group, gender, dental arch, but also facial type. The identification of the dental eruption sequence is important because it may be favorable or not to occlusal regulation in case of a lack of eruption space. The facial type can be useful to preventive and interceptive orthodontic procedures that ensure the balanced development of the dental occlusion, mandible and facies as a whole. Further studies need to be conducted on larger population samples to determine the dynamics of dental eruption in relation to facial types. The collected data are essential for the study of intra- and inter-population variations, of interest in various fields: anthropology, forensic medicine and clinical practice.

Conflict of interests

The authors declare that they have no conflict of interests.

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