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ОСОБЛИВОСТІ ДИНАМІКИ ФОРМУВАННЯ ЗУБНИХ РЯДІВ У ДІТЕЙ І ПІДЛІТКІВ ТА МОЖЛИВОСТІ ДЕНТАЛЬНОЇ ІМПЛАНТАЦІЇ

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Реферат

Мета. *Вивчення особливостей розвитку та формування зубних рядів у дітей віком 4-13 років для встановлення динаміки їх розвитку та визначення оптимальних термінів встановлення імплантів у разі передчасної втрати постійних зубів.*

Матеріал і методи. *Обстежено 1861 дитини у віці від 3 до 13 років та досліджено динаміку розвитку їх зубощелепної системи протягом 3-5 років. Обстеження проводили у дітей з нормогнатичним прикусом та розвитком щелеп. Протягом 5 років у визначені терміни отримували відбитки та на контрольних моделях здійснювали наступні виміри: ширину зубних дуг верхньої та нижньої щелеп за точками Пона і за зовнішніми контурами в ділянці ікл, премолярів, перших молярів, довжину верхньої зубної дуги та зубних рядів верхньої та нижньої щелеп, ширину ділянки чотирьох різців верхньої та нижньої щелеп. Вивчено 1152 контрольні моделі та проведено 9614 вимірів.*

Результати й обговорення. *Дані про розвиток верхньої та нижньої щелеп у дитячому та підлітковому віці свідчать, що сума ширини чотирьох різців як на верхній, так і на нижній щелепах найактивніше збільшується у віці від 6 до 8 років, далі наступає дещо повільніший ріст цієї ділянки. Ширина щелеп в ділянці ікол, премолярів та першого моляра змінюється впродовж усього періоду змінного прикусу, хоча і не значно. Динаміки зміни розмірів зубних рядів верхньої та нижньої щелеп, починаючи з 6-річного віку і до завершення формування постійного прикусу збільшується на 18-22 мм, при чому у віці 7-8 років спостерігається певна стабілізація розмірів зубних рядів. Найбільш активний ріст зубних рядів у довжину виявлено у віці 6-9 років.*

Висновок. *Отримані дані щодо вікового формування зубних рядів і, відповідно, альвеолярних відростків щелеп у дітей можуть стати підґрунтям для обґрунтування можливості застосування імплантатів для заміщення поодиноко втрачених зубів у підлітковому віці.*

Ключові слова: *діти, контрольні моделі, альвеолярні відростки, зубні ряди*

Abstract

THE PECULIARITIES OF DYNAMICS OF THE DENTITION FORMATION IN CHILDREN AND ADOLESCENTS AND POSSIBILITIES OF DENTAL IMPLANTATION

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Aim. *To study the peculiarities of dentition development and formation in children aged from 4 to 13 years of age, to establish the dynamics of development, and to determine the optimal period of dental implants application.*

Material and Methods. *1861 children aged from 3 to 13 years were examined and the dynamics of their dentition formation during 3-5 years were investigated. The survey was conducted in children with normognathic occlusion and jaw development. The maxilla and mandible impressions and control models were conducted in the selected group of children during 5 years in the same period, and the following dimensions were carried out: the width of upper and lower jaws in the dental arch by Pona points and the external contours in canines, premolars, first molars areas; the length of the upper dental arch and dentition of upper and lower jaws; the sum of width of four upper and lower incisors. 1152 control models were studied, and 9614 measurements were taken.*

Results and Discussions. *The jaws development data indicate that the sum of the width of the four incisors on the upper and lower jaws undergoes the most active growth from 6 to 8 years; then the growth of this area is somewhat slower. The width of the jaws in the canines, premolars and first molar areas changes during the whole period of mix dentition, although not significantly. Changes in the size of the dental arch of the upper and lower jaws, starting from 6 years of age and till the end of the permanent occlusion formation increases by 18-22 mm, but at the age of 7-8 years some stabilization in the dental arch sizes is seen. The most active changes of the dental arch length were discovered at the age of 6-9 years.*

Conclusion. *The obtained data concerning the age of formation of dentition and, accordingly, alveolar processes of jaws in children can serve as a basis for substantiation of the possibility of dental implants application to replace the single missing teeth in adolescence.*

Key words: *children, control models, alveolar jaws, dental arch*

Introduction

The problem of prosthetic rehabilitation of children and adolescents with missed permanent teeth is widely discussed in literature. However, there is no consensus among researchers as to the methods of prosthetic treatments in adolescents with missing teeth, and prosthetic rehabilitation in growing patients is sporadic. The choice of prosthesis design demands a based approach taking into account the patient's age, type, location and length of the defect, presence of dental

anomalies, and individual characteristics [2, 6, 13].

Partial dentures are the method of choice, but such types of prostheses contain certain complications: the increase in the frequency of dental caries and periodontal diseases development; and the acceleration of the alveolar bone resorption in the areas of the missing tooth [7].

Over the past 10-15 years the dental implants application in children and adolescents with dentition defects is increasingly discussed in scientific publications. All discussions are based on two top priority issues: a) the relationship of the dental implant with permanently changeable conditions in the maxillofacial area as a result of growth and development and, b) the prosthesis effect on the jaws growth.

According to the basic research of the cranio-facial complex [3, 8] and the modern scientific data [1, 9, 10, 11, 15], the growth and formation of the jaw is in close connection with the tooth development and eruption. At the end of tooth eruption (with the exception of third molars) the active formation of the alveolar bone is completed; the jaw bones cease to increase in the sagittal and transversal directions and only a slight vertical growth continues.

In this regard, a significant number of researchers recommend the application of dental implants to replace the defects of dentition in growing patients [5, 6, 7, 12]. The authors believe that application of the dental implants during growth allows saving the volume of the bone and there is no significant effect on the jaw bones growth. The minor vertical changes can be compensated by the prosthesis replacement.

The conclusions the researchers arrived at in their studies [5] proved that the replacement of prosthetic designs was needed by about half of patients, but on average after 7,8±4,5 years after implantation, and the bone segment with dental implant was not retarded in growth compared to the adjacent areas of jaws.

However, the researchers do not recommend applying this method of prosthetic rehabilitation before puberty because of the possible growth disorders of jaws and formation of the maxillofacial complex; they emphasize, however, that such growth disorders do not occur in all patients [12]. Other researchers [13, 14] share the same opinions.

No disturbances were noted in the development of the maxillofacial area in patients of 9-14 years of age after intraosseous implantation of the missing first mandible molar [4].

Furthermore, bone preserving in the missing teeth area, from a physiological point of view, is perhaps one of the reasons for the dental implants application in growing patients [7]. It is well known that in case of congenital adentia there is a significant disturbance in the growth and development of the alveolar jaw area.

Notwithstanding the controversial opinions, it is very important to determine the age dentition formation dynamics in children and adolescents in the sequence of eruption, which provide the formation of alveolar bone which serves the base for dental implants applications. It is also important to take into account the accelerated overall development of adolescents in recent years and some changes in the timing of permanent teeth eruption.

The aim is to study the peculiarities of dentition development and formation in children of the 4-13 years of age, to establish the dynamics of development, and to determine the optimal period of dental implants application.

Material and Methods

The teeth and alveolar areas development in children aged from 4 to 13 years old were examined during the period of 3-5 years. The children were evaluated in kindergartens and schools. The results were recorded in the special forms and were compared annually. Out of the number of examined children, a group with normognathic occlusion and normognathic development of jaws (the absence of dentition defects, extensive involvement of teeth by dental caries, the absence of anomalies in location and development of separate adjacent teeth) was selected.

The upper and lower jaws impressions and control models were made in the selected group of children during 5 years in the same period. The following dimensions were carried out on the control models:

- the width of upper and lower jaws in the dental arch by Pona points and external contours in canines, premolars and first molars areas;
- the length of the upper dental arch from the cutting edges of the central incisors to the line "A";
- the sum of width of four upper and lower incisors which was determined from the mesial edge of the same incisor on both sizes of jaws.

The dimensions were carried out using specially developed calipers and symmetroscope and a flexible millimeter ruler. 1,861 children were evaluated and

Table 1

Amount of the studies examined in children

Age, years	The number of examined children					The number of control models						The number of measurements on the models					
	total	I testing	II testing	III testing	IV testing	total	I testing	II testing	III testing	IV testing	V testing	total	I testing	II testing	III testing	IV testing	V testing
4	41	41	-	-	-	40	40	-	-	-	-	300	300	-	-	-	-
5	75	42	33	-	-	72	46	26	-	-	-	540	345	195	-	-	-
6	66	40	26	-		66	36	30	-	-	-	485	270	225	-	-	-
7	140	140	-	-	-	120	120	-	-	-	-	1020	1020	-	-	-	-
8	273	143	130	-	-	182	66	176	-	-	-	1547	561	986	-	-	-
9	359	125	128	106	-	200	34	56	110	-	-	1700	289	476	935	-	-
10	353	131	100	122	-	164	80	24	26	34	-	1394	680	204	221	289	-
11	299	-	123	97	79	168	-	52	16	22	78	1428	-	442	136	187	663
12	183	-	-	118	65	-	-	34	-	-	14	408	-	-	289	-	119
13	72	-	-	-	72	92	-	-	-	52	40	782	-	-	-	442	340
Total	**1861**	**662**	**540**	**443**	**216**	**1152**	**442**	**304**	**186**	**108**	**132**	**9614**	**3465**	**2528**	**1581**	**918**	**1122**

1,152 control models were studied; 9,614 measurements were performed (Table. 1). According to the aim of the study to determine the dynamics of changes in dentition sizes depending on the age, individuals who had contracted no pathological changes within the 5 years were selected.

The sizes of the dentitions in children aged from 4 to 13 years old are presented in Table 2, and the dental arches sizes dynamics - in Figs. 1, 2, 3.

Results and Discussion

The jaws development data indicate that the sum of the four permanent incisors width increased by 9 mm for the maxilla and 4 mm for the mandible in comparison with the sum of the four primary incisors. These changes begin at the age of 6 and finish at 8 years of age ($p<0,05$).

Further on, the sum of the dimensions in incisors area changed slowly, which may indicate a slightly slowed further jaws growth. Some difference in the sizes of four incisors in dynamics is due to the fact that in 6 and 8 year-old children it is not always possible to determine the sizes of incisors accurately, as they are subjected to permanent teeth eruption at this time.

In case of temporary absence of one of the incisors or at the start of its eruption, the space available for it in the dental arch was measured, which does not quite accurately describe the size of the teeth.

The width of the jaws in the canines area starting from 4 to 13 years increases by 3 mm; for the upper and lower jaws, in the area of premolars it increases by 2 mm; in the first permanent molars areas from 7 to 13 years - by 3 mm. In the area of canines, the main changes take place at the age of 6 in premolars, and in molars areas - from 9 to 12 years of age (Table 2).

The longitude of the upper jaw undergoes

Table 2

The maxilla and mandible sizes in children from 4 to 13 years old (mm)

Age (years)	The sum of four incisors	Distance between III.....III 3.....3		IV.....IV 4.....4		V.....V 5.....5	6.....6		the maxilla length	the dental arch length, $\sum_{12}^{10}$
		by Pona method	by the external contours	by Pona method	by the external contours	by the external contours	by Pona method	by the external contours		
Maxilla										
4	24,0±1,83	28,2±1,2	35,6±0,1	36,0±1,41	44,0±0,27	50,0±0,25	-	-	31,0±3,53	83,0±3,8
5	24,2±2,2	38,7±2,6	36,5±0,13	36,4±1,48	46±0,11	50,3±0,22	-	-	32,4±2,9	84,5±3,8
6	25,8±2,5	31±4,7	26,8±0,26	36,4±±2,6	43,5±0,25	50,5±0,72	-	-	31,8±3,6	83±4,2
7	34,9±0,58	30,6±0,38	37,8±0,18	36,2±0,34	43,2±0,22	50,0±0,16	47,0±0,32	54,7±0,18	43,1±0,33	83,1±0,59
8	34,8±0,56	30,8±0,35	38±0,09	36,6±0,31	45,0±0,1	50,6±0,1	47,2±0,28	56,0±0,1	43,8±0,34	84,8±0,63
9	32,9±3,7	30,9±3,2	37,7±0,07	36,5±3,8	43,0±0,09	49,6±0,15	47,5±2,9	56,0±0,09	42,7±2,5	106,5±5,4
10	34,5±0,36	30,4±3,4	39,0±2,1	37,5±2,2	45,7±2,42	51,3±2,85	48,8±2,8	57,3±2,39	43,2±4,1	106,4±4,3
11	34,3±0,46	31,0±1,6	38,4±1,38	37,4±2,8	45,3±2,18	49,7±4,1	48,4±4,1	59,3±2,53	44,7±3,1	107,3±5,6
12	34,27±0,27	31,8±3,2	39,0±2,8	37,9±2,9	45,3±1,85	50,7±2,05	50,2±3,8	57,2±2,5	45,5±4,1	106,0±5,1
13	34,3±0,3	31,6±3,5	39,2±1,56	38,3±2,9	46,0±5,6	50,7±3,8	50,2±2,2	57,2±2,6	45,4±2,6	105,6±4,2
Mandible										
4	18,0±1,79	21,8±1,79	30,0±0,28	33,1±1,85	38,6±0,16	46,8±0,23	-	-	-	76,0±4,5
5	19,9±1,5	22,3±2,82	30,3±0,09	33,2±3,5	38,0±0,1	45,7±0,12	-	-	-	76,4±3,7
6	21,4±1,8	23,5±2,0	31,4±0,53	33,6±3,7	39,0±0,54	46,4±0,24	-	-	-	76,1±4,6
7	25,4±0,42	23,3±0,34	32,0±0,07	32,8±0,33	40,4±0,09	46,0±0,08	42,8±0,35	50,0±0,05	-	75,5±0,48
8	24,9±0,38	24,2±0,32	32,4±0,13	34,7±0,31	40,0±0,11	46,5±0,15	42,9±0,32	51,4±0,07	-	76,0±0,46
9	24,4±3,6	24,0±3,4	32,0±0,05	34,7±4,2	39,0±0,89	46,0±1,1	42,7±3,7	51,4±1,3	-	97,8±4,8
10	24,5±0,4	24,3±2,5	32,0±1,7	34,9±3,2	40,0±6,2	46,6±5,0	43,3±3,5	52,7±3,67	-	96,1±5,2
11	24,7±0,32	24,2±2,2	31,5±1,83	35,1±2,6	39,0±3,5	45,6±2,99	43,7±5,2	52,0±4,7	-	96,5±2,9
12	24,6±0,41	24,4±2,8	32,2±1,34	35,8±4,2	40,0±2,73	45,8±2,52	44,7±3,7	52,0±2,5	-	95,2±4,3
13	24,8±0,35	24,3±3,3	31,5±3,1	35,8±1,9	39,2±2,9	46,0±2,8	44,5±2,8	52,5±3,2	-	94,7±5,1

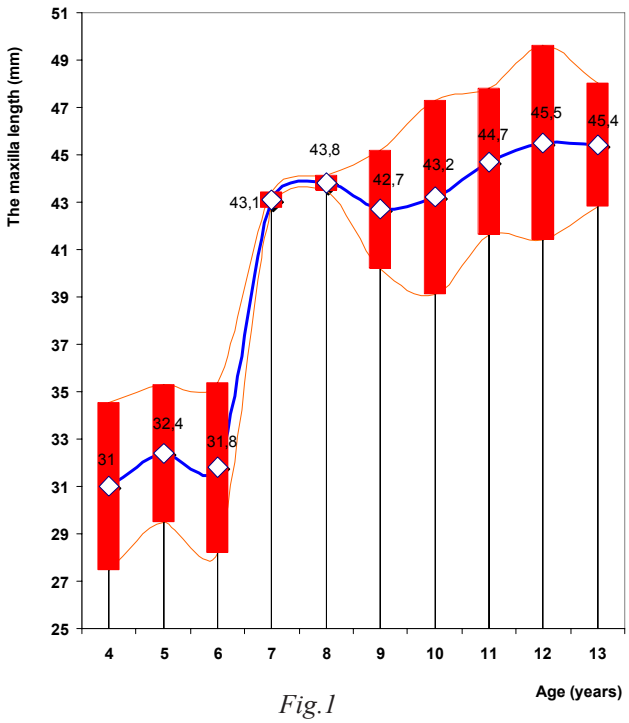

Fig.1
The dynamics of maxilla length development in children from 4 to 13 years old

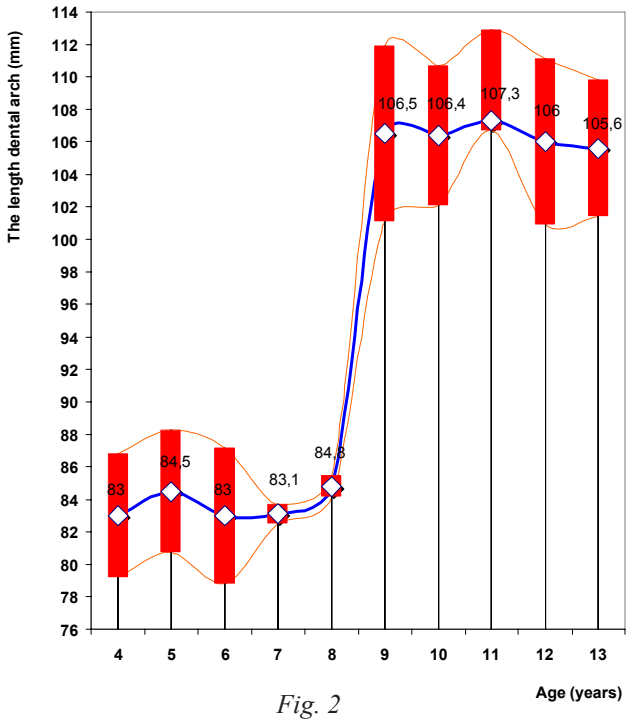

Fig. 2
The dynamics of maxilla dental arch length in children from 4 to 13 years old

significant changes. Since the age of 6, this dimension increases more than 10 mm - from 31,8±3,6 mm to 45,4±2,6 mm, ($p<0,01$) up to the end of the permanent occlusion formation period (excluding third molars).

The evaluation of age dynamics of dental arches formation and, therefore, the alveolar processes of both jaws in children from 4 to 13 years revealed the following peculiarities:

- the length of the maxilla and mandible dental arch from the age of 6 to the end of the permanent dentition formation (excluding third molars eruption) increases by on 18-22 mm on average, ($p<0,01$);
- an interesting phenomenon was revealed when at the age from 7 to 8 years the maxilla and mandible dental arch length had stable value for all examined children without significant deviations. The average data were 83-84 mm for the maxilla, 75-7 6mm for the mandible (fig. 1-3).
- the most active longitude development of jaws and dentition occur at the age from 6 to 9 years, from 83±4,2 mm to 106,5±5,4 mm in the maxilla and from 76,1±4,6 mm to 97,8±4,8mm in the mandible, ($p<0,05$). After that it may be stabilized with some individual differences in the range of 1-2 mm ($p>0,05$), (fig. 1-3).

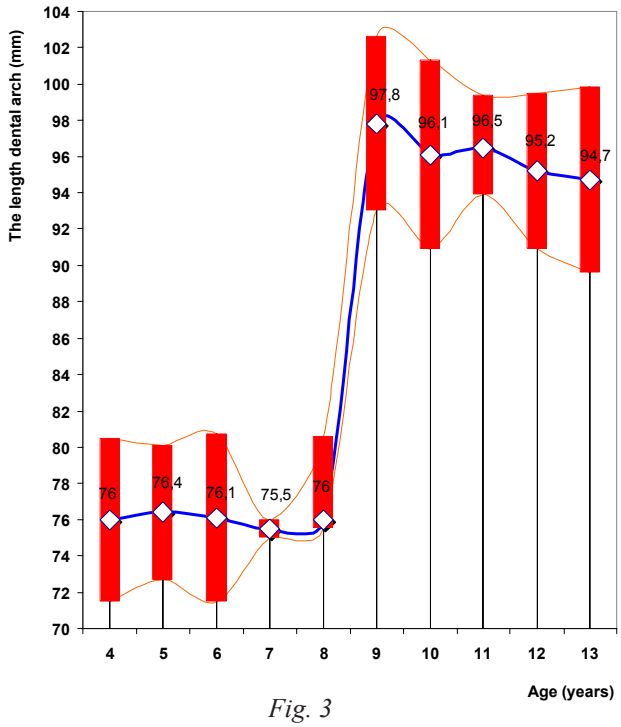

Fig. 3
The dynamics of mandible dental arch length in children from 4 to 13 years old

Conclusion

The data as to the age of formation of dentition and, accordingly, alveolar processes of jaws in children can serve as a basis for substantiation of the possibility of dental implants application to replace the single missing teeth in adolescence.

References

1. Proffit W.R. Contemporary orthodontics. - Mosby, Inc. - 2000. - P. 58-96.

2. Doroshenko S.I. Features dental implants in adolescence / S.I. Doroshenko, O.V. Storozhenko, E.A. Kulhinskyy // Ukrainian Dental Almanac. - 2010. - №5..- S. 66-68. Ukrainian: (Дорошенко С.І. Особливості дентальної імплантації у підлітковому віці / С.І. Дорошенко, О.В. Стороженко, Є.А. Кульгінський // Український стоматологічний альманах. - 2010. - №5.- С. 66-68).
3. Modern orthodontics / per. from English. ; ed. L.S. Persina. - M.: MEDpress-inform, 2006. - 559 p.). Russian: (Современная ортодонтия / пер. с англ. ; под ред. Л. С. Персина. - М.: МЕДпресс-информ, 2006.- 559 с.).
4. Zhuk A.A. Effectiveness of intraosseous implants at an early removal of the first permanent molars: Abstract. Dis. on scientific. PhD degree. honey. Sciences: spec. 00.21 14. "Dentistry" / Beetle A. O.- Volgograd, 2007. - 18 p. Russian: (Жук А.О. Эффективность применения внутрикостных имплантов при раннем удалении первых постоянных моляров: автореф. дис. на соискание учен. степени канд. мед. наук: спец. 14. 00.21 "Стоматология"/ Жук А.О. - Волгоград, 2007. - 18 с.).
5. Dental implants are viable alternative for compensating oligodontia in adolescents/ S. Heuberer, G.Dvorak, C. Mayer [et al.]// Clin Oral Implants Res.-2014.-V.34.- P. 57-64.
6. Osseointegrated dental implants in growing children: a literature review / N. Mankani, R. Chowdhary, B.A. //J Oral Implantol.- 2014. - V.5. - P. 627-631.
7. Mishra S. K.Dental implants in growing children / S. K. Mishra, N. Chowdhary, R. Chowdhary // J Indian Soc Pedod Prev Dent.- 2013. - V.1. - P.3-9.
8. Bjork A., Skieller V. Normal and abnormal growth of mandible: a synthesis of longitudinal cephalometric implant studies over the period of 25 years. - Eur J Orthodont - V. 10. - 1988. - P. 177-179.
9. Springate S.D. Natural reference structures in the human mandible: a systematic search in children with tantalum implants/ S. D. Springate // Eur J Orthod - 2010. - V. 4. - P. 354-362.
10. Carmichael R.P. Dental implants, growth of the jaws, and determination of skeletal maturity/ R.P. Carmichael, G.K. S?ndor // Atlas Oral Maxillofac. Surg Clin North Am. - 2008. - V.16.- P.1-9.
11. Liu Y.P. Mandibular growth, remodeling, and maturation during infancy and early childhood/Y.P. Liu, R.G. Behrents, P.H. Buschang// Angle Orthod. - 2010. - V. 80.- P. 97-105.
12. Sharma A.B. Using implants for the growing child / A.B. Sharma, K. Vargervik // J Calif Dent Assoc. - 2006. - V.9 - P.719-724.
13. Prachar P, Vanek J. Tooth defects treated by dental implants in adolescents. Scr Med (Brno) .- 2003.- V. 76.- p.5-8.
14. Oesterle L.J, Cronin R.J.Jr. Adult growing, aging and the single-tooth implants. Int J Oral Maxillofac.Implants. - 2000. - V. 15:252-60.
15. Brahmin J.S. Dental implants in children/ J.S. Brahmin// Oral Maxillofacial Surg Clin NAm. - 2005. - V. 17. - P. 375-381.