UDC 616. 314. 2-007. 19-053. 5

MANDIBULAR INCISOR CROWDING IN THE MIXED DENTITION. ADVANCES IN ETIOLOGY, EARLY DIAGNOSIS AND ORTHODONTIC TREATMENT

I. Tokarevich,
D. Rublevsky

ТЕСНОЕ ПОЛОЖЕНИЕ ПОСТОЯННЫХ НИЖНИХ РЕЗЦОВ. СОВРЕМЕННЫЙ ПОДХОД К ЭТИОЛОГИИ, РАННЕЙ ДИАГНОСТИКЕ И ЛЕЧЕНИЮ

И. В. Токаревич,
Д. В. Рублевский

Investigators report mandibular incisor crowding (MIC) to be one of the prevailing orthodontic disorders in children with the mixed dentition [1, 4, 13].

Understanding its etiology, rational treatment planning, considering data of timely highly effective diagnostic procedures allow a clinician to correspond patient's demands and achieve predictable treatment results.

Review of 235 literature sources on this issue [5] provided us with a contemporary scientific data concerning the etiology, early diagnosis and orthodontic treatment of MIC in the mixed dentition.

Etiology of MIC is widely present in scientific literature. The factors predisposing to disorder formation are following: an abnormal position of the dental germs; an ectopic eruption of the permanent lateral incisors, canines and molars; inherited risk for enlarged mesiodistal incisor size; supernumerary teeth; disturbance in tooth eruption time and sequence; transposition of teeth; uneven resorption and early loss of deciduous teeth; decay of permanent and deciduous teeth and its complications; functional disorders (abnormal habits, consequences of ENT inflammatory disorders, other reasons); alveolar bone volume reduction and tooth wear decrease as a result of phylogenesis, inherited predisposition etc [6, 8, 13, 15, 28, 37]. Most of the factors have been profoundly studied and described.

It is well known that the most typical sequence of deciduous teeth exfoliation in a lower dentition (canine, first molar, second molar) is different from the typical sequence in an upper dental arch (first molar, canine, second molar) [13, 15, 34]. The mesiodistal size of permanent lower canine exceeds the size of deciduous canine, thus the eruption of permanent tooth leads to space deficit formation in anterior region of the dentition. At the time of eruption of permanent canine leeway space cannot be used for the resolution of space deficit in the anterior region because it is occupied by deciduous molars. An increase of mesiodistal size of lower deciduous molars leads to a mesial displacement of permanent canines and an aggravation of space deficiency. The difference in a mesiodistal size of lower first deciduous molar and first premolar is insignificant, thus MIC doesn't resolve during exfoliation of the first deciduous molar. Only after exfoliation of lower second deciduous molar that is significantly wider than second lower premolar a leeway space can be utilized to resolve crowding. However, shortly after an exfoliation of second deciduous molars, the first permanent molars tends to displace and rotate mesially, thus impeding full distal drifting of previously mesially displace lower canines and correction of the MIC [13,39].

Despite the information presented above, an interrelationship between mesiodistal size of deciduous molars and MIC formation in the mixed dentition has not yet been scientifically proven and has been presented only in some scientific sources [1, 2]. Therefore, the further study of this aspect is urgent.

The review revealed a variety of methods for predicting the mesiodistal unerupted tooth size of supporting zones. These methods are widely used for an early diagnosis of the severity of space deficiency ina dental arch in order to a substantiate expediency of permanent tooth extraction for correction of MIC in the mixed dentition. Scientists name 3 main groups of such methods: correlation methods [19, 35] (their principle is based on the high linear correlation between the mesiodistal tooth size and the corresponding values of teeth that has not yet been erupted), radiologic methods [29], and combined methods [16] (combination of radiologic and correlation methods).

Most of correlation methods are not multipurpose, because they were based on the data acquired from patients of Northern American descent, while dental and facial characteristics vary among the different ethnical and racial groups. Moreover, these methods don't allow to predict the sizes of individual teeth and their application is limited when the predictors (key teeth) are not in the oral cavity. Correlation methods do not allow evaluating the position of permanent canine and premolars in the alveolar bone before their eruption. Traditional radiologic and combined methods are proven to be more accurate, but their accuracy can be limited due to distortions of real tooth sizes and impossibility of their three dimensional visualization on plane films. Individual methods of predicting are labour-intensive. In some cases, the amount of diagnostic information does not correspond to the amount of the effective dose acquired by the patient.

Though the CBCT allow eliminating most of the drawbacks of plane radiographs [3, 7, 9, 12], there is no data available on the effectiveness of CBCT application in patients with the mixed dentition to predict the width of unerupted teeth of supporting zones. The only data available is experimentally obtained from the studies of the jaws made of artificial materials imitating the alveolar bone and teeth [27]. Therefore, it is necessary to study the clinical effectiveness of CBCT use in children for prediction of unerupted tooth width of supporting zones.

The review also allowed us to understand that investigator's opinion on the necessity of MIC early treatment is ambiguous. Some authors state that an early orthodontic treatment of such disorder is pointless [38, 40]. They mention the possibility of MIC spontaneous correction during growth and development; the low level of patient's compliance at an early age; the patient's emotional burnout, and the uncertainty of early treatment aims paired with high cost of 2 phase treatment compared to an orthodontic intervention in the permanent dentition.

On the other hand, some contemporary publications substantiate the necessity of an early orthodontic intervention at the MIC [14, 25, 28, 41]. According to their data, a timely correction of the disorder in the mixed dentition allows achieving the stable treatment results, reducing the rate of permanent teeth extractions and time of second phase of treatment.

Clinicians have developed a number of early treatment strategies for patients with MIC: proclination of mandibular incisors, transverse development of the dental arch, distalization of permanent molar, space management with or without application of bracket system during the second phase of treatment, selective interproximal stripping of permanent and deciduous teeth, extraction of permanent teeth [10, 11, 17, 18, 23, 26, 28, 30, 31].

Nonextraction early treatment strategies are advocated by scientists and clinicians at present time. It has become obvious that extraction techniques have a negative influence on facial esthetics, function of TMJ, post-retention stability [14, 25, 28,].

Among all early nonextraction treatment options of MIC, a space management in the mixed dentition is proved to provide the best results in terms of post-retention stability [11, 20-22, 24]. This treatment strategy is cost effective for both, patient and doctor, and allows avoiding or simplifying the future orthodontic treatment.

Clinical effectiveness of lip bumper application in patients with the mixed dentition for MIC treatment is proven [23,30], however, a post-retention stability of treatment results is questionable, and the appliance is relatively complex for patient's adaptation [33]. On top of that possibility of second permanent molar impaction after a lip bumper application is reported and has not been thoroughly investigated.

Data of several investigators supports the effectiveness of lingual arch in patients with MIC [11, 14, 32]. However, authors are not unanimous in their opinion on the biomechanics of the appliance and its influence on the dentition, on ways of attainment of additional space. Precise indications for application of lingual arch in combination with selective extractions or interproximal stripping of deciduous teeth have not been determined.

Study objectives.

Three study objectives were set: to study the influence of mesiodistal size of deciduous teeth on formation of MIC in the mixed dentition; to devise the method of prediction of mesiodistal size of unerupted canines and premolars on basis of CBCT data analysis and to test its effectiveness; to analyze the effectiveness of various methods of space management in lower dental arch and scientifically substantiate expediency of their application depending on severity of initial value of lower incisor crowding.

Materials and methods.

For achieving the study objectives, three directions of research were carried out.

To address the first objective, we studied a group of 531 children (298 boys and 233 girls) aged 7-11 (9.17±0.15). In each case, the full orthodontic diagnosis was made. Measiodistal size of lower deciduous molars was measured intraorally with an application of digital caliper with sharpened measuring tips (accuracy of measurement is 0.01 mm). Second lower deciduous molars were measured only, taking into account scientific data that indicates relative identity of the width of first lower deciduous molar and first lower premolar. Mesiodistal size of the teeth with interproximal decay and big restorations were not registered.

In order to address the second objective, a mesiodiastal size of 23 unerrupted teeth (6 permanent canines and 17 premolars) was predicted on basis of CBCT data, obtained from 6 patients with mixed dentition. Indications for the CBCT were following: a retention of permanent teeth, a transposition of dental germs, an apical periodontitis of several deciduous teeth etc. Gendex CB-500 digital tomograph was used for the study. Selection of the study mode (volume of scanning and scanning time) was based on the disorder localization. Voxel size was maintained permanent

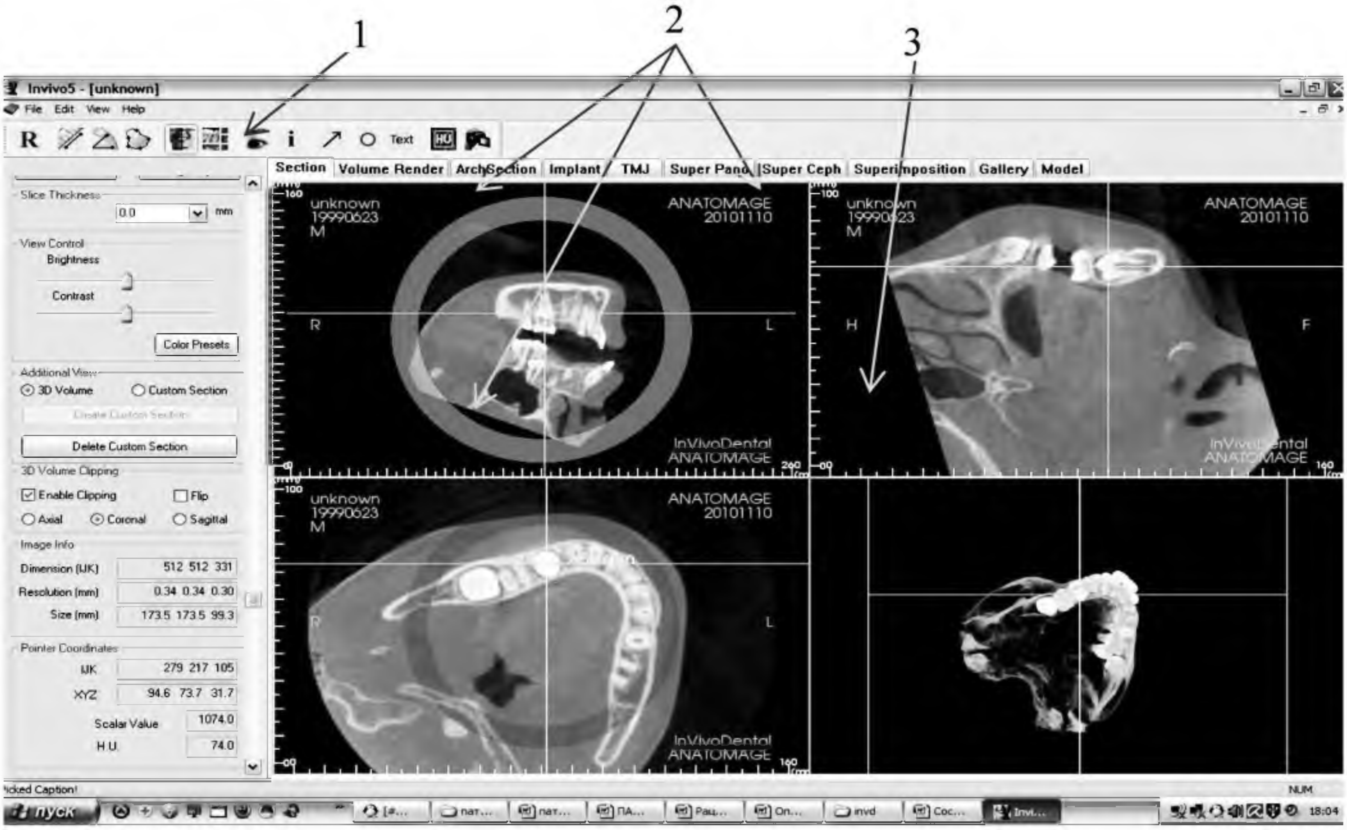

Figure. 1 – Section mode. Marks are explained above

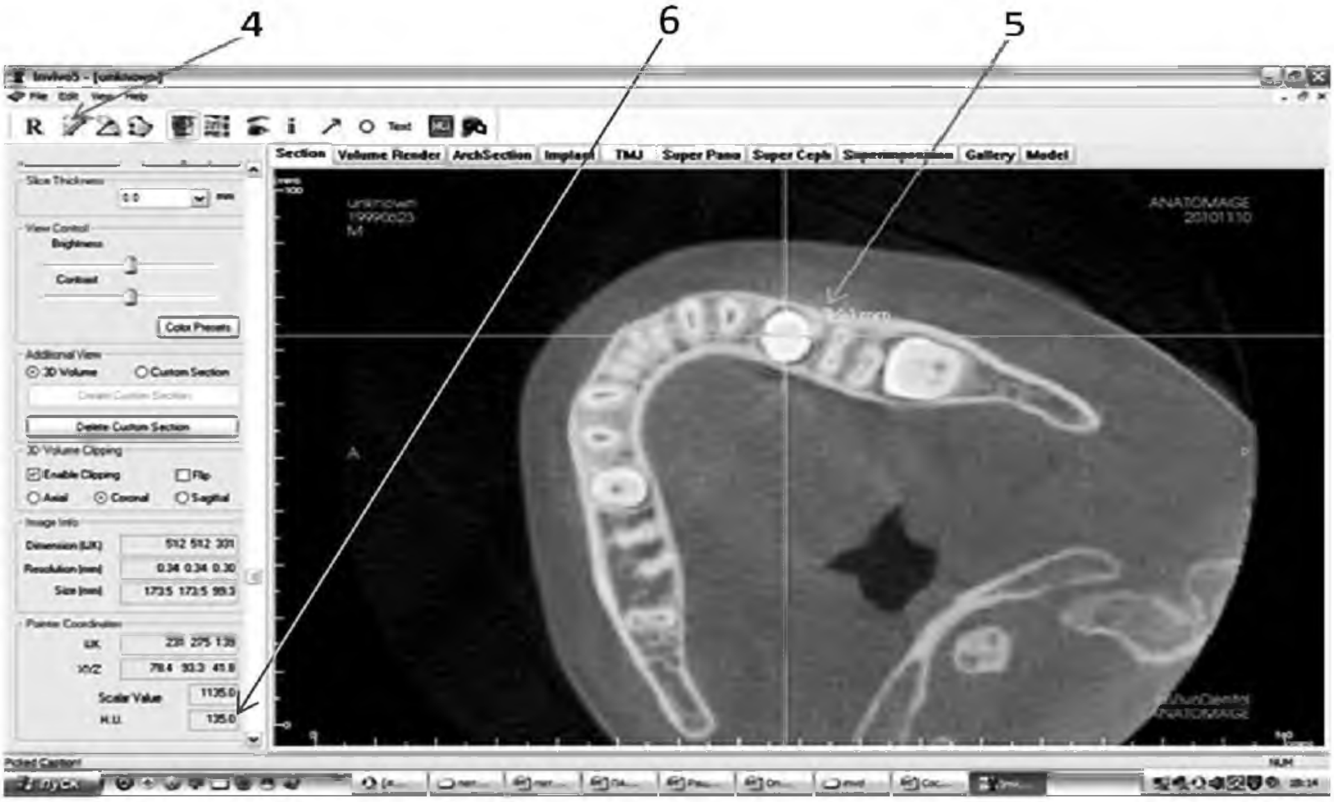

Figure. 2 – Selection of the points duringthe measurement of mesiodistal tooth size, 3.5 in the section mode. Marks are explained in the text

(0.3 mm) in order to exclude differences in quality of obtained radiologic data.

Prediction was made in accordance with a developed algorithm (instruction of Ministry of health of Republic of Belarus № 062 0412 / 08.06.2012).

Algorithm was realized by an analysis of digital information obtained after CBCT. Analysis was performed in the digital software InVivo Dental 5.1 (Anatomage, California) in two modes (section mode, volume render mode).

Study in section mode (**Figure 1(1)**) included the rotation of the section including studied tooth with the control of 3D model (3), the image of studied tooth was then perpendicular oriented to its occlusal surface (2).

After that, the two most distant points on the enamel surface of visualized tooth in the area of tooth equator were picked (**Figure 2**) on basis of scalar values of density of visualized tissue (Haunsfield scale) (6). Literature data concerning enamel density (2100-4000 Haunsfield units) was taken into consideration during the analysis. The distance was measured by a virtual measurement tool (4) and was saved in the database (5).

Analysis in volume render mode (**Figure 3, (8)**) allowed an exclusion of surrounding tissues (for example bone) (9) that were impeding the visualization of studied tooth with the use of following options: bone (10), teeth (11), freehand sculpture (7). Later with the use of distant measurement option, a mesiodistal tooth size was measured in its widest part (the information about a tooth position was analyzed during the measurement).

Predicted values of mesiodistal size of studied teeth were compared to the actual values obtained after the tooth measurement after their eruption or extraction. The effectiveness of prediction of mesiodistal size of uneruppted teeth of supporting zones on basis of CBCT data analysis was statistically tested.

In order to address the third objective, 63 children with MIC in the mixed dentition were treated in the clinic of orthodontic department of Belorussian state medical university. Patients were divided into 3 groups. First group of 23 children (control group) was treated with a passive lingual arch (passive space management). Second group of 16 patients was treated with an active lingual arch (with omega-loops) in combination with se-

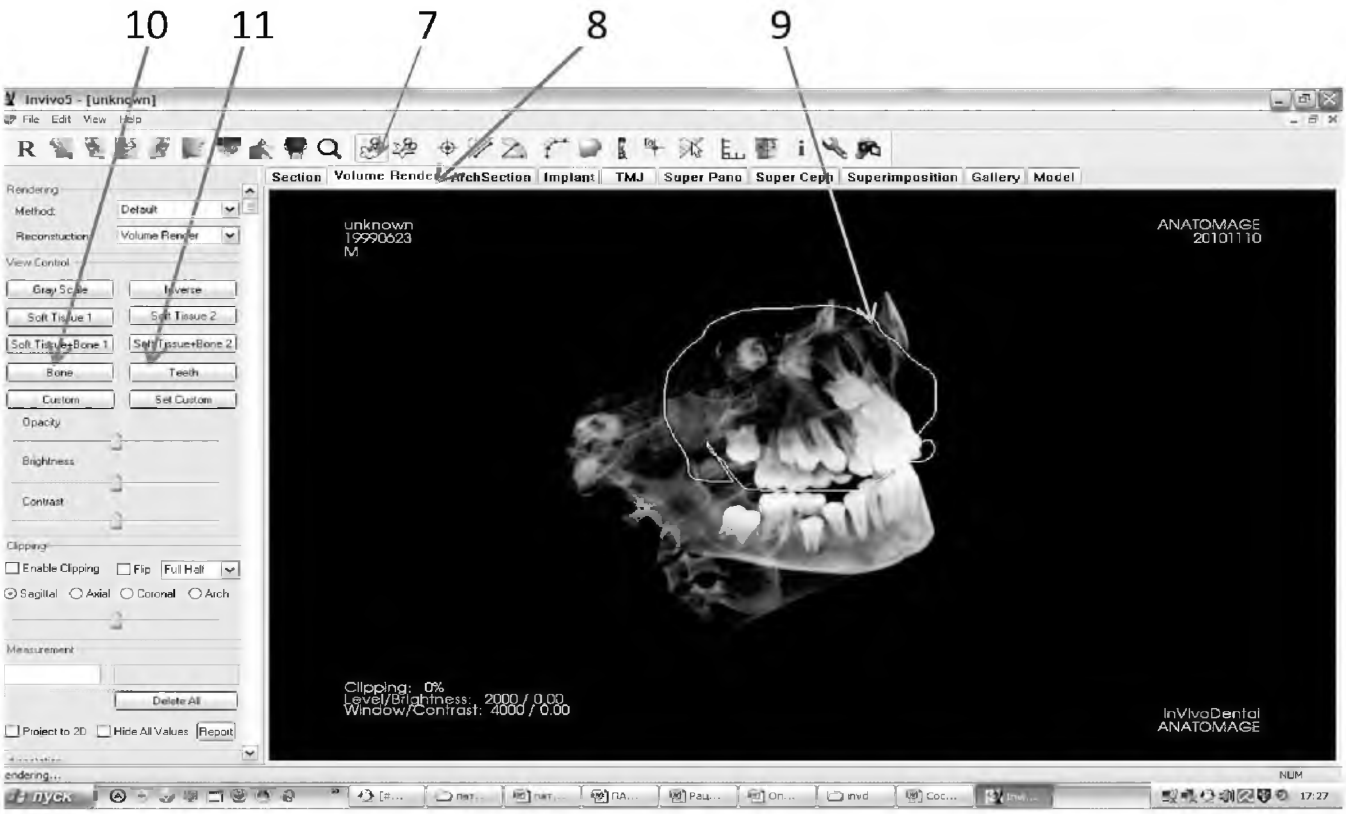

Figure. 3 – Volume render mode window. Marks are explained in the text

lective interproximal stripping of deciduous molars and canined (IPR group). Patients of the third group (24 children) were treated with an active lingual arch in combination with selective extractions of deciduous molars and canines. Difference between patients in age, gender and type of malocclusion were not statistically significant.

Pretreatment plaster models of 63 patients were studied according to the methods developed by Andreeva L., Slabkovskaya A., Korkhaus G., Little R. M, Johnston L. E. -Tanaka M. M. Additionally, a lower arch depth and predicted total value of space deficit were studied. The later value presents an aggregate of space deficiency values obtained during the measurement according to Little R. M. and Johnston L. E. -Thanaka M. M. methods. Post treatment plaster models were studied according to the methods developed by Andreeva L., Slabkovskaya A., Korkhaus G., Lundström A. Besides that, the true values of mesiodistal size of lower permanent canines and premolars, leeway space size, mandibular arch depth, the value of actual total pretreatment space deficit were measured. The later value represents a predicted total value of space deficit, accounting an actual mesiodistal size of permanent canines and premolars measured after an eruption.

Skeletal and dental changes were studies on the lateral cephalograms. Cephalograms were studied in accordance to a complex method comprising the methods developed by Tokarevich I., Schwarz A. M., Hasund A., Ricketts R. M., Jarabak J. R., Steiner C. C., Holdway R. A.

Changes of first lower permanent molars position were studied by measuring distances between point X (the deepest point of the inner contour of cortical plate of mandibular symphisis) that is proven to be reliable skeletal reference point [36] and point B6 (the most eminent point of the distal crown surface of the first permanent lower molar); point bif 6 (point of bifurcation of first lower permanent molar); point apd 6 (point of the apex of distal root of first permanent lower molar). Positions of B6; bif 6; apd 6 were defined on the cephalograms as mean position of two points (left and right side) of the same name.

Results:

Samples included 238 (44.82 %) children with MIC and 293 (55.7 %) without MIC. Data concerning mean values of the mesiodistal size of second deciduous molars presented in the **table 1.**

Study revealed a significant difference ($p<0.01$) between mean values of mesiodistal sizes of lower second deciduous molars in compared groups. Mesiodistal size of measured teeth was 0.20 ± 0.06 mm greater in MIC group (T = 3.29, p = 0.01).

Statistically proven difference allowed evaluating the influence of mesiodistal size of second lower deciduous molars on formation of MIC in the mixed dentition considering the peculiarities of sequence of deciduous teeth exfoliation in a lower dental arch.

Statistical analysis revealed significant (F=10.90, $p<0.001$) influence of group of 3 factors (mean value of mesiodistal size of lower second deciduous molars, presence of permanent lower canine in the dentition, absence of defect of lower dentition) on the MIC formation in the mixed dentition. Acquired statistical data proves a direct link between the increase of value of mesiodistal size of second lowed deciduous molars and the MIC formation in patients with the presence of lower permanent canines and intact lower mixed dentition.

Study of the effectiveness of proposed radiologic method of prediction revealed that values acquired on basis of CBCT data analyzed in section mode have the strongest correlation with the actual values and this method of prediction has the highest probability coefficient compared to other types of analysis **(Table 2).**

Deviation of the predicted values from the actual mesiodistal size of studied teeth was significantly lower in case with a prediction on basis of CBCT data analysis in section mode comparing to other methods **(Table 3,4).**

Thus, the results of statistical analysis prove the effectiveness of proposed method of prediction of mesiodistal size of unerupted canines and premolars. Method of prediction, based on the study of CBCT data, analyzed in section mode is proven to be the most accurate.

Values of the parameters measured during the study of plaster models as well as values of linear and angular skeletal and dental parameters measured on the lateral cephalograms of control group are shown in applications A and B.

The difference between the value of total actual space deficiency before the treatment and the amount of space deficit in the lower dental arch after the treatment for control group was not significant.

This indicates that with passive space management the amount of space acquired during the treatment is in range of size of leeway space. The data supports the fact that application of this treatment strategy is effective in patients with the amount of MIC not greater than the size of leeway space.

Study failed to reveal clinically and statistically significant changes of skeletal and dental parameters on the lateral cephalograms in the control group. Significant increase of the size of lower jaw

Table 1

Mean values of mesiodistal size of second deciduous molars in study groups

Measured tooth	Mesiodistal size of second deciduous molars (mm)				Level of significance
	MIC group		Control group		
	n	M ± m	n	M ± m	
7.5	134	9.85 ± 0.05	180	9.62 ± 0.05	p < 0.01
8.5	135	9.91 ± 0.05	189	9.71 ± 0.05	p < 0.01
Mean of left and right side	269	9.87 ± 0.04	369	9.66 ± 0.04	p < 0.01

Table 2

Correlation coefficient of predicted values, acquired on basis of various types of prediction methods and their actual values; probability coefficient of the methods

Index	Method of prediction			
	CBCT (section mode)	CBCT (volume render mode)	CBCT (mean of both modes)	Panoramic X – ray
Probability coefficient (LR)	1.08	0.85	1.00	0.46
Correlation coefficient (p)	0.93 p < 0.05	0.82 p < 0.05	0.87 p < 0.05	0.26 p > 0.05

Table 3

Value and range of deviation of predicted values from an actual mesiodistal tooth size

Index	Method of prediction			
	CBCT (section mode)	CBCT (volume render mode)	CBCT (mean of 2 modes)	Panoramic X – ray
Deviation from actual value Me (25 %; 75 %)	0.06(0.02;0.22)	0.23(0.1;0.43)	0.09(0.05;0.31)	0.64(0.44;0.94)
Range of deviation from an actual value (mm)	0.20	0.33	0.26	0.50

Table 4

Significance of the difference between the deviation values of predicted and actual values

Method of prediction	Significance of the difference			
	CBCT (section mode)	CBCT (volume render mode)	CBCT (mean of 2 modes)	Panoramic X – ray
CBCT (section mode)	–	T = 27.00, $p < 0.001$	T = 64.00, $p < 0.05$	T = 7.00, $p < 0.001$
CBCT (volume render mode)	–	–	T = 21.00, $p < 0.001$	T = 17.00, $p < 0.001$
CBCT (mean of both modes)	–	–	–	T = 10.00, $p < 0.001$
Panoramic X-ray	–	–	–	–

base and PTV – 6 were conditioned by the natural growth, insignificant labial proclination of lower incisors and distal tipping of first permanent molars is conditioned by the adjustment of lingual arch during its fixation.

Clinical case of MIC treatment in the control group is depicted in **figure 4.**

The values of the parameters measured during the study of plaster models, the values of linear and angular skeletal and dental parameters measured on the cephalograms of the IPR group are shown in the applications C and D.

The amount of space deficit in the lower dental arch after treatment for the group was statistically lower by 1.09 mm (T = 24.00; $p < 0.05$) compared to the total actual space deficiency value before the treatment.

Such difference indicates that in cases with application of active lingual arch and selective interproximal stripping of deciduous canines and molars the amount of space acquired during the treatment exceeds the size of leeway space by 1mm. This data indicates that an application of this treatment strategy is effective in patients with the amount of MIC that do not exceed the difference in size between permanent and deciduous teeth of the supporting zones by more than 1 mm.

Acquirement of additional space (exceeding the size of leeway space) in IPR group was supported by increase of lower dental arch depth.

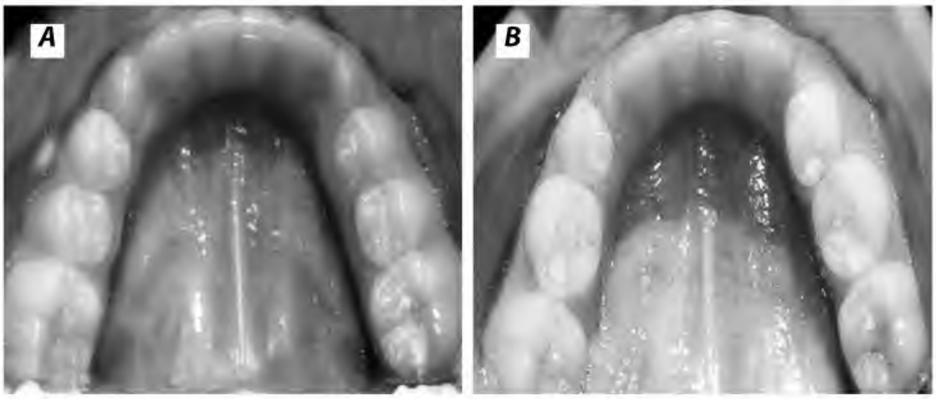

Figure 4 – Patient K., aged 10. Lower dentition before (a) and after 15 month of treatment (b)

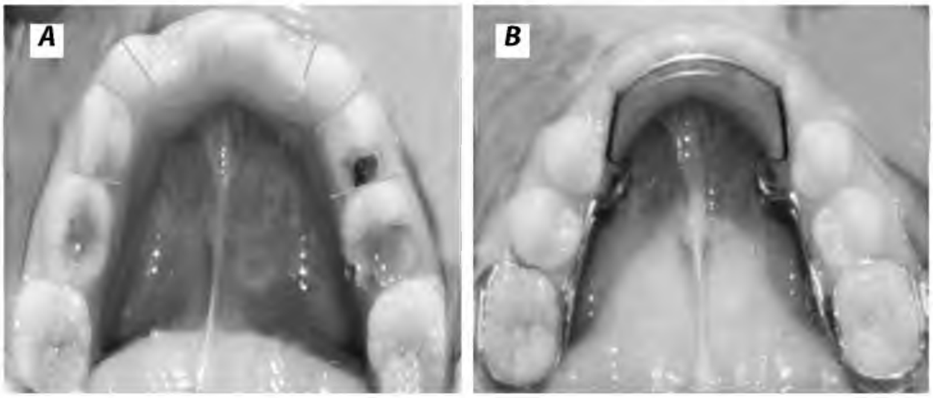

Figure. 5 – Patient P. aged 9. Lower dentition before (a) and after 16 month of treatment (b), (red lines indicate the areas of stripping)

Changes of skeletal parameters during the treatment of patients from IPR group were not significant.

The increase of lower dental arch depth was conditioned by distal tipping of first permanent molars (increase of linear and angular values B6 – X, 6 – ML, increase of the angular parameter 6 – ML) and insignificant labial proclination of lower incisors (increase of IMPA and 1 – NB) .

Clinical case of MIC treatment in children from IPR group is depicted in **figure 5.**

The values of the parameters measured during the study of plaster models, linear and angular parameters acquired from the lateral cephalograms of patients from extraction group, are shown in the applications E and F.

The amount of space deficit in the lower dental arch after treatment in this group was statistically lower by 3.86 mm ($T = 21.00$, $p < 0.001$) compared to total actual space deficiency value before treatment.

Such difference indicates that in cases with application of active lingual arch and selective extractions of deciduous canines and molars the amount of space acquired during treatment exceeds the size of leeway space by 4 mm. The data indicates that application of this treatment strategy is effective in patients with the amount of MIC that do not exceed the difference in size between permanent and deciduous teeth of the supporting zones by more than 4 mm.

Acquirement of additional space (exceeding the size of leeway space) in patients from extraction group was supported by increase of the lower dental arch depth and the length of anterior segment of lower dental arch.

Study of lateral cephalograms revealed that increase of the parameters mentioned above was conditioned by labial inclination of lower incisors (increase of angular values IMPA, 1 – NB, 1 – APg) and their labial displacement (increase of linear values 1 – NB, 1 – APg,) and distal tipping of the first permanent lower molars (increase of the angular parameter 6 – ML°).

Significant increase of 6 – ML° value, increase of linear value bif 6 – X, accompanied by an absence of significant changes of B6 – X value indicate mesial displacement of first permanent molars during the treatment. Such displacement is proved by a decrease of distance between first permanent molars after treatment (application E) resulted from the tooth migration to the narrower portion of the alveolar bone. Mesial displacement of the molars is conditioned by recurring loss of contact between the anterior portion of the lingual arch and lingual surface of lower incisors resulted from a proclination of the incisors, caused by the activation of the appliance, absence of obstacles for mesial displacement of permanent first molars after an extraction of lower second deciduous molars.

Changes of skeletal parameters during the treatment in the extraction group were not significant.

Clinical case of MIC treatment in patients from extraction group is depicted in **figure 3.**

Conclusions:

1. In cases with intact lower dentition and typical sequence of deciduous teeth exfoliation, the formation of mandibular incisor crowding in the mixed dentition can be caused by an enlargement of mesiodistal size of second lower deciduous molars.

2. Method of prediction of mesiodistal size of unerrupted teeth of supporting zones, based

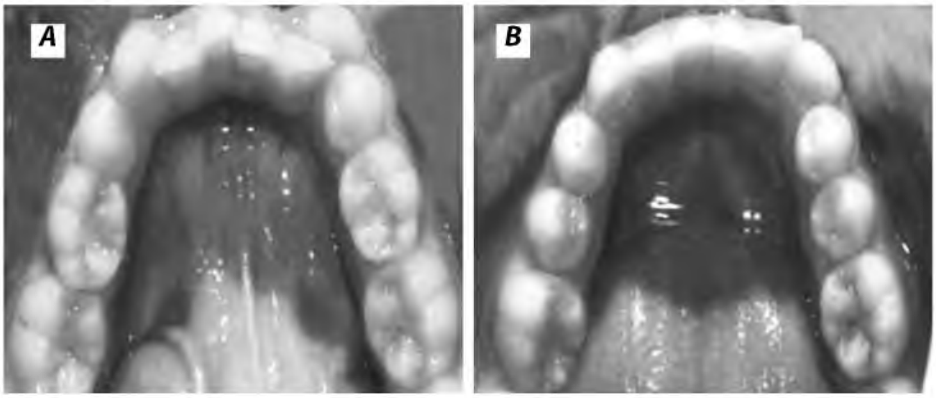

Figure 6. – Patient F., 10 years old. Lower dentition before (a) and after 5 month of treatment (b)

sor crowding that doesn't exceed the size of leeway space.

4. Application of active lingual arch combined with a selective interproximal reduction of deciduous canines and molars in the mixed dentition is effective in patients with the amount of mandibular incisor crowding that exceeds the size of leeway space by no more than 1 mm.

on the analysis of CBCT data is reliable. Predicted values acquired in section mode of analysis are proven to be the most accurate.

3. Passive space management (application of passive lingual arch) in the mixed dentition is effective in patients with the amount of mandibular incisor crowding that doesn't exceed the size of leeway space.

5. Application of active lingual arch combined with a selective extractions of deciduous canines and molars in the mixed dentition is effective in patients with the amount of mandibular incisor crowding that exceeds the size of leeway space by no more than 4 mm.

Application A

Values of parameters acquired during the study of plaster models in control group

Measured parameter	Pretreatment Me (25; 75 %) mm	Posttreatment Me (25; 75 %) mm	Level of significance
Upper intercanine width (5.3-6.3) according to Andreeva L.	25.48 (23.58; 26.13)	29.27 (25.44; 30.21)	–
Lower intercanine width (5.3-6.3) according to Andreeva L.	20.86 (19.85; 23.02)	20.65 (19.34; 24.71)	–
Upper intermolar width (5.5-6.5) according to Andreeva L.	31.93 (29.93; 36.39)	31.70 (29.31; 33.70)	–
Lower intermolar width (7.5-8.5) according to Andreeva L.	28.32 (27.45; 30.25)	30.72 (28.57; 32.33)	T = 63.50, p < 0.05
Upper intermolar width (1.6-2.6) according to Andreeva L.	34.53 (32.74; 36.02)	34.16 (33.22; 36.67)	–
Lower intermolar width (3.6-4.6) according to Andreeva L.	32.42 (31.70; 33.82)	32.30 (3.58; 33.86)	–
Upper intercanine width (5.3-6.3) according to Slabkovskaya A.	32.04 (30.28; 34.16)	34.93 (32.69; 36.34)	–
Lower intercanine width (7.3-8.3) according to Slabkovskaya A.	25.58 (24.47; 28.76)	26.40 (24.53; 29.76)	–
Length of the anterior segment of upper dental arch according to G.Korkhaus	16.96 (15.34; 19.03)	18.56 (15.70; 20.02)	–
Length of the anterior segment of lower dental arch according to G.Korkhaus	15.16 (13.81; 16.21)	16,03 (14,90; 17,20)	T = 25.00, p < 0.001
Lower dental arch depth	29.69 (28.93; 31.18)	29.33 (27.93; 30.87)	–
Upper dental arch depth	30.02 (29.22; 31.34)	29.76 (29.08; 31.40)	–

Application B

Values of angular and linear skeletal and dental parameters acquired during the study of lateral cephalograms in the control group

Parameter	Pretreatment M ± m/Me (25; 75 %) mm/°	Posttreatment M ± m/Me (25; 75 %) mm/°	Level of significance
NSBa, °	132.00 (130.00; 136.00)	132.00 (130,00; 136.00)	–
SNA, °	84.00 (82.00; 86.00)	84.00 (81,00; 85.00)	–
SNB, °	80.00 (78.00; 84.00)	80.00 (77.00; 82.00)	–
NSL – ML, °	31.34 ± 1.23	33.84 ± 3.19	–
NSL – NL, °	5.71 ± 0.72	5.69 ± 0.61	–
NL – ML, °	26.30 ± 1.08	29.86 ± 3.35	–
NSGn, °	66.44 ± 0.74	66.58 ± 0.77	–
ArGoMe, °	125.07 ± 1.20	124.46 ± 1.3	–
NMe / SGo %	68.82 ± 2.27	67.71 ± 1.74	–
A' – PNS, мм	48.07 ± 0.42	48.69 ± 0.56	–
B' – J', мм	47.08 ± 0.67	48.14 ± 0.57	p < 0.01
ii, °	127.13 ± 1.6	123.86 ± 1.99	p < 0.05
1 – NL, °	70.97 ± 1.05	70.65 ± 1.19	–
1 – NA, °	22.41 ± 1.22	22.26 ± 1.32	–
1 – NA, мм	3.81 ± 0.27	4.47 ± 0.29	p < 0.001
IMPA, °	98.08 ± 1.64	100.04 ± 1.93	p < 0.01
1 – NB, °	27.52 ± 1.26	29.58 ± 1.58	p < 0.01
1 – NB, мм	4.37 ± 0.27	4.69 ± 0.26	–
1 – APg, °	23.19 ± 1.11	2.52 ± 1.40	p < 0.001
1 – APg, мм	2.30 ± 0.35	2.70 ± 0.34	–
6 – NL, °	107.80 ± 1.05	106.91 ± 1.19	–
PTV – 6, мм	12.00 (11.00; 14.00)	14 (11.50; 15.79)	T = 39.00, p < 0.01
6 – ML, °	96.00 ± 0.84	9820 ± 1.14	p < 0.01
B6 – X, мм	46.35 (43.26; 46.71)	46.71 (43.76; 48.49)	T = 31.00, p < 0.01
Bif6 – X, мм	36.47 (34.46; 3726)	36.59 (34.34; 37.64)	–
Apd 6 – X, мм	37.38 (35.31; 38.17)	36.95 (34.35; 37.94)	–

Application C

Values of parameters acquired during the study of plaster models in the IPR group

Measured parameter	Pretreatment Me (25; 75 %) mm	Posttreatment Me (25; 75 %) mm	Level of signifi-cance
Upper intercanine width (5.3-6.3) according to Andreeva L.	25.45 (24.89; 26.15)	27.17 (24.06; 28.10)	–
Lower intercanine width (5.3-6.3) according to Andreeva L.	20.71 (19.29; 23.87)	22.16 (20.20; 23.21)	–
Upper intermolar width (5.5-6.5) according to Andreeva L.	31.40 (29.27; 33.73)	30.37 (28.94; 33.09)	–
Lower intermolar width (7.5-8.5) according to Andreeva L.	28.22 (26.27; 29.59)	29.52 (27.37; 33.49)	T = 21.00, p < 0.05

Upper intermolar width (1.6-2.6) according to Andreeva L.	34.37 (32.19; 36.29)	35.10 (32.80; 37.23)	–
Lower intermolar width (3.6-4.6) according to Andreeva L.S.	32.83 (31,54; 34,29)	32.21 (31,29; 35,09)	–
Upper intercanine width (5.3-6.3) according to Slabkovskaya A.	33.52 (31.30; 34.54)	35.91 (32.42; 35.06)	–
Lower intercanine width (7.3-8.3) according to Slabkovskaya A.	25.90 (24.57; 28.50)	29.98 (25.73; 30.15)	T = 12.00, $p < 0.05$
Length of the anterior segment of upper dental arch according to G.Korkhaus	17.95 (15.45; 1841)	18.05 (16.47; 19.37)	–
Length of the anterior segment of lower dental arch according to G.Korkhaus	14.35 (13.58; 15.24)	15.95 (15.41; 17.40)	T = 14.00, $p < 0.01$
Lower dental arch depth	29.86 (29.03; 31.24)	30.50 (29.77; 31.80)	T = 11.00, $p < 0.001$
Upper dental arch depth	30.22 (28.97; 30.73)	30.15 (29.41; 30.92)	T = 19.00, $p < 0.05$

Application D

Values of angular and linear skeletal and dental parameters acquired during the study of lateral cephalograms in the IPR group

Parameter	Pretreatment M ± m/Me (25; 75 %) mm/°	Posttreatment M ± m/Me (25; 75 %) mm/°	Level of significance
NSBa, °	132.31 ± 1.12	132.31 ± 1.12	–
SNA, °	83.50 (81.50; 85.00);	83.50 (81.25; 84.00)	–
SNB, °	80.50 (79.00; 82.00)	80.50 (75.50; 81.00)	–
NSL – ML, °	36.37 ± 4.43	32.12 ± 1.23	–
NSL – NL, °	11.77 ± 5.97	5.22 ± 0.51	–
NL – ML, °	33.06 ± 4.69	28.13 ± 1.18	–
NSGn, °	68.13 ± 2.27	65.65 ± 0.74	–
ArGoMe, °	123.81 ± 2.04	125.52 ± 1.31	–
NMe/SGo %	67.81 ± 2.38	66.02 ± 0.99	–
A' – PNS, мм	47.46 ± 0.80	48.12 ± 0.70	$p < 0.05$
B' – J', мм	46.93 ± 0.70	47.99 ± 1.02	$p < 0.01$
ii,°	124.34 ± 2.52	121.53 ± 1.92	–
1 – NL, °	68.34 ± 0.94	67.72 ± 1.19	–
1 – NA, °	25.06 ± 1.02	26.13 ± 1.15	–
1 – NA,мм	4.76 ± 0.26	4.85 ± 0.35	–
IMPA, °	96.12 ± 1.28	99.84 ± 1.54	$p < 0.01$
1 – NB, °	27.87 ± 1.26	30.34 ± 1.21	$p < 0.001$
1 – NB, мм	4.26 ± 0.30	4.93 ± 0.37	–
1 – APg, °	30.13 ± 4.84	28.44 ± 1.04	–
1 – APg, мм	8.72 ± 6.15	3.05 ± 0.39	–
6 – NL, °	106.97 ± 1.51	106.12 ± 1.31	–
PTV – 6, мм	12.75 (11.00; 14.00)	14.00 (12.44; 14.75)	–
6 – ML, °	97.46 ± 0.79	102.28 ± 1.53	$p < 0.001$
B6 – X, мм	46.97 (45.44; 48.04)	48.05 (46.38; 49.16)	T = 8.00, $p < 0.01$

Bif6 – X, мм	37.04 (35.48; 38.56)	37.96 (35.49; 38.67)	–
Apd 6 – X, мм	37.50 (34.95; 38.94)	36.70 (33.81; 38.21)	T = 27.00, p < 0.05

Application E

Values of parameters acquired during the study of plaster models in the extraction group

Measured parameter	Pretreatment Me (25; 75 %) mm	Posttreatment Me (25; 75 %) mm	Level of significance
Upper intercanine width (5.3-6.3) according to Andreeva L.	25.47 (23.95; 26.31)	30.99 (27.30; 32.7)	T = 30.00, p < 0.01
Lower intercanine width (5.3-6.3) according to Andreeva L.	21.74 (18.65; 24.16)	22.42 (20.53; 25.61)	–
Upper intermolar width (5.5-6.5) according to Andreeva L.	31.80 (30.16; 33.91)	32.03 (30.52; 35.42)	–
Lower intermolar width (7.5-8.5) according to Andreeva L.	28.43 (27.52; 30.64)	30.25 (28.45; 31.15)	T = 31.00, p < 0.01
Upper intermolar width (1.6-2.6) according to Andreeva L.	35.08 (33.55; 36.47)	35.32 (33.76; 36.95)	–
Lower intermolar width (3.6-4.6) according to Andreeva L.	33.51 (31.57; 34.6)	31.64 (30.17; 33.45)	T = 25.00, p < 0.001
Upper intercanine width (5.3-6.3) according to Slabkovskaya A.	33.15 (31.41; 34.04)	36.44 (34.76; 37.7)	T = 51.00, p < 0.01
Lower intercanine width (7.3-8.3) according to Slabkovskaya A.	25.76 (23.22; 27.77)	28.26 (25.79; 3029)	T = 32.00, p < 0.01
Length of the anterior segment of upper dental arch according to G.Korkhaus	18.89 (17.09; 20.25)	18.8 (17.64; 20.35)	–
Length of the anterior segment of lower dental arch according to G.Korkhaus	15.31 (14.44; 17.22)	17.76 (16.59; 18.96)	T = 58.00, p < 0.05
Lower dental arch depth	30.75 (29.65; 32.21)	31.65 (29.9; 33.22)	T = 71.00, p < 0.05
Upper dental arch depth	31.00 (30.06; 3172)	31.64 (30.95; 32.84)	T = 27.00, p < 0.001

Application F

Values of angular and linear skeletal and dental parameters acquired during the study of lateral cephalograms in the extraction group

Parameter	Pretreatment M ± m/Me (25; 75 %) mm/°	Posttreatment M ± m/Me (25; 75 %) mm/°	Level of significance
NSBa, °	132.92 ± 1.16	132.92 ± 1.16	–
SNA, °	82.75 (82; 84.50)	83 (80.50; 84.50)	–
SNB, °	79.00 (77.50; 82)	79.00 (77.00; 80.50)	–
NSL – ML, °	30.20 ± 0.84	29.52 ± 0.86	–
NSL – NL, °	7.50 ± 0.73	7.25 ± 0.71	–
NL – ML, °	24.44 ± 1.03	23.89 ± 1.03	–
NSGn, °	66.45 ± 0.5	66.10 ± 0.53	–
ArGoMe, °	123.37 ± 0.96	122.00 ± 1.3	–
NMe/SGo %	68.08 ± 0.79	67.13 ± 0.78	–

A' – PNS, мм	47.24 ± 0.5	48.40 ± 0.47	p < 0.001
B' – J', мм	45.77 ± 0.69	47.31 ± 0.75	p < 0.001
ii, °	124.97 ± 2.36	118.47 ± 1.86	p < 0.001
1 – NL, °	69.54 ± 1.55	67.60 ± 12	–
1 – NA, °	22.47 ± 1.54	24.52 ± 0.92	–
1 – NA, мм	3.88 ± 0.33	4.50 ± 0.26	p < 0.05
IMPA, °	99.89 ± 1.31	106.04 ± 1.45	p < 0.001
1 – NB, °	28.25 ± 0.96	32.62 ± 1.39	p < 0.01
1 – NB, мм	4.35 ± 0.25	5.34 ± 0.27	p < 0.001
1 – APg, °	24.95 ± 0.86	29.60 ± 1.2	p < 0.001
1 – APg, мм	2.12 ± 0.43	3.02 ± 0.35	p < 0.001
6 – NL, °	106.62 ± 0.88	107.50 ± 1.04	–
PTV – 6, мм	11.25 (10; 13.50)	12.00 (11.00; 13.50)	–
6 –ML, °	95.40 ± 0.80	101.26 ± 1.43	p < 0.001
B6 – X, мм	46.66 (45.14; 47.87)	46.17 (45.19; 4776)	–
Bif6 – X, мм	36.76 (35.37; 37.89)	36.45 (35.25; 38.22)	–
Apd 6 – X, мм	36.92 (35.94; 38.84)	35.63 (33.85; 37.21)	p < 0.001

References:

1. Dmytrenko, M. (2005), «Correctional removal of deciduous teeth in the complex orthodontic treatment of close position of anterior teeth in the mixed dentition», Abstract of Cand. Sci. (Med.) dissertation, 14.01.22, Poltava Ukrainian Medical Stomatological Academy, Poltava, Ukraine.
2. Kuroedova, V. et al. (2007), «One more factor of crowding of permanent teeth», *Ukrainskyi stomatologichnyi almanakh*, no. 2, pp. 23–27.
3. Lendegolts, Zh, Karton, E. and Vagapov, Z. (2010), «The use of cone-beam computed tomography in orthodontics», *Ortodontiya*, no. 4, pp. 7–9.
4. Melnichenko, E., Terekhova, T. and Melnikova, E. (2001), «Structure of dentoalveolar anomalies in urban children of Belarussia», *Sovremennaya stomatologiya*, no. 2, pp. 35–37.
5. Rublevskiy, D. (2012), «Space management in the dentition in children aged 7-11», Abstract of Cand. Sci. (Med.) dissertation, 14.01.14, Belorussian State Medical University, Minsk, Belorussia.
6. Tsukor, S., Baranova, O. and Tsukor, T. (2009), «On the relationship between the occlusion pathology and logopedic violations», *DentalMarket*, no. 1, pp. 57–60.
7. Chibisova, M. (2010), «The possibility of dental volumetric tomography in the planning and improving the quality of the orthodontic treatment», *Dental Yug*, no. 4, pp. 40–45.
8. Shevchenko, Yu. (2001), «Pathological habitual actions in children (clinic, dynamics, therapy)», *Voprosy psikhicheskogo zdoroviya detej i podrostkov*, no. 1, pp. 58–64.
9. Berco M. et al. (2009), «Accuracy and reliability of linear cephalometric measurements from cone-beam computed tomography scans of a dry human skull», *Am. J. Orthod. Dentofacial Orthop*, Vol. 136, no. 1, P. 17, e. 1–e. 9.
10. Allias, D. and Melsen B. (2003), «Does labial movement of lower incisors influence the level of the gingival margin? A case control study of adult orthodontic patients», *Eur. J. Orthod*, Vol. 2, no. 4, pp. 343–352.

11. Brennan, M. M. and Gianelly, A. A. (2000), «The use of the lingual arch in the mixed dentition to resolve incisor crowding», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 117, no. 1, pp. 81–85.
12. Stratemann, S. A. et al. (2008), «Comparison of cone beam computed tomography imaging with physical measures», *Dentomaxillofac. Radiol*, Vol. 37, no. 2, pp. 80–93.
13. Proffit, W. R. et al. (2006), «Contemporary orthodontics», Mosby, N. Y., USA.
14. Gianelly, A. A. (2002), «Treatment of crowding in the mixed dentition», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 121, no. 6, pp. 569 –571.
15. Graber, T. M. (2000), «Orthodontics, current principles and concepts», Mosby, Philadelphia, USA.
16. Hixon, E. H. and Oldfather, R. E. (1958), «Estimation of sizes of unerupted cuspids and bicuspid teeth», *Angle Orthod*, Vol. 28, no. 2, pp. 236–240.
17. Kinzinger, G., Fritz, U. and Diedrich, P. (2003), «Combined therapy with pendulum and lingual arch appliances in the early mixed dentition», *J. Orofac. Orthop,* Vol. 64, no. 3, pp. 201–213.
18. Keski-Nisula, K. (2008), «Orthodontic intervention in the early mixed dentition: A prospective, controlled study on the effects of the eruption guidance appliance», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 133, no. 2, pp. 254–260.
19. Legovic, M. and Novosel, A. (2003), «Regression equation for determining crown diameters of canines and premolars», *Angle Orthod*, Vol. 73, no. 3, pp. 314–318.
20. Little, R. M., Riedle, R. A. and Artun, J. (1988), «An evaluation of changes in mandibular anterior alignment from 10 to 20 years post retention», *Am. J. Orthod. Dentofacial Orthop*, Vol. 93, no. 5, pp. 423–428.
21. Little, R. M., Riedle, R. A. and Stein, R. A. (1990), «Mandibular arch length increase during the mixed dentition: postretention evaluation of stability and relapse», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 97, no. 5, pp. 393–404.
22. Little, R. M. (2002), «Stability and relapse: early treatment of arch length deficiency», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 121, no. 6, pp. 578–581.
23. Ferris, T. et al. (2005), «Long term stability of combined rapid palatal expansion – lib bumper therapy followed by full fixed appliances», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 128, no. 3, pp. 310–325.
24. Rebellato, J. et al. (1997), «Lower arch perimeter preservation using the lingual arch», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 112, no. 4, pp. 449–456.
25. McNamara, J. A. Jr. (2002), «Early intervention in the transverse dimension: is it worth the effort?», *Am. J. Ortod. Dentofacial. Orthop*, Vol. 121, no. 6, pp. 572–574.
26. Melsen, B. and Dalstra, M. (2003), «Distal molar movement with Kloehn headgear; is it stable?», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 123, no. 4, pp. 374–378.
27. Nguyen, E., Boychuk, D. and Orellana, M. (2011), «Accuracy of cone beam computer tomography in predicting the diameter of unerupted teeth», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 140, no. 2, pp. 59–66.
28. Greenfield, R. L. (2010), «Non ex factors. Coordinated arch development», Daehan Narae Publishing, Korea.
29. Suzuki, S. et al. (1976), «Prediction of the size of unerupted cuspid and bicuspids from the oblique cephalometric films», *Nihon Kyosei. Shika. Gakkai. Zasshi*, Vol. 35, no. 2, pp. 122–129.
30. Sabri, R. (2010), «Treatment of a severe arch-length deficiency with anteroposterior and transverse expansion: long-term stability», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 137, no. 3, pp. 401–411.
31. Sheridan, J. J. (1985), «Air – rotor stripping», *J. Clin. Orthod*, Vol. 19, no. 1, pp. 43–59
32. Singer, J. (1974), «The effect of the passive lingual arch on the lower denture», *Angle Orthod*, Vol. 44, no. 2, pp. 146–155.
33. Housley, J. A. et al. (2003), «Stability of transverse expansion in the mandibular arch», *Am. J. Orthod. Dentofacial. Orthop*, Vol. 124, no. 3, pp. 288–293.

34. Moyers, R. E. et al. (1976), «Standarts of human occlusal development», Center for Human Growth and Development, University of Michigan, Michigan, USA.
35. Tanaka, M. M. and Johnston, L. E. (1974), «The prediction of the size of unerupted canines and premolars in a contemporary orthodontic population», *J. Am. Dent. Assoc*, Vol. 88, no. 4, pp. 798–801.
36. Krarup, S. et al. (2005), «Three-dimensional analysis of mandibular growth and tooth eruption», *J. Anat*, Vol. 207, pp. 669–682.
37. Turkkahraman, H. and Sayin, M. O. (2004), «Relationship between mandibular anterior crowding and lateral dentofacial morphology in the early mixed dentition», *Angle Orthod*, Vol. 74, no. 6, pp. 759–764.
38. Tweed, C. H. (1944), «Indications for extractions of teeth in orthodontic procedures», *Am. J. Orthod*, Vol. 30, no. 8, pp. 405–428.
39. Watanabe, E., Demirjian, A. and Buschang, P. (1999), «Longitudinal post-eruptive mandibular tooth movements of males and females». *Eur. J. Orthod*, Vol. 21, no. 5, pp. 459–468.
40. White, L. (1998), «Early orthodontic intervention», *Am. J. Orthod. Dentofacial. Ortop*, Vol. 113, no. 1, pp. 24–28.
41. Woodside, D. G. (2000), «The significance of late development crowding to early treatment planning for incisor crowding», *Am. J. Orthod. Dentofacial. Ortop*, Vol. 117, no. 5, pp. 559–561.

Abstract

MANDIBULAR INCISOR CROWDING IN THE MIXED DENTITION.
ADVANCES IN ETIOLOGY, EARLY DIAGNOSIS AND ORTHODONTIC TREATMENT

I. Tokarevich, D. Rublevsky

The article contains review of data concerning etiology, early diagnosis and treatment of mandibular incisor crowding in mixed dentition as well as results of own research on this problem. Influence of mesiodistal size of second lower deciduous molars on formation of lower incisor crowding was scientifically proven. Efficacy of developed method of prediction of the size of unerrupted canines and premolars in mixed dentition was confirmed. Comparative analysis of lower dental arch space management methods was performed; the expediency of their use considering the amount of space deficiency in dental arch was substantiated.

Keywords: lower permanent incisor crowding, mixed dentition, prediction of teeth size, space management.

Резюме

ТЕСНОЕ ПОЛОЖЕНИЕ ПОСТОЯННЫХ НИЖНИХ РЕЗЦОВ.
СОВРЕМЕННЫЙ ПОДХОД К ЭТИОЛОГИИ, РАННЕЙ ДИАГНОСТИКЕ И ЛЕЧЕНИЮ

И. В. Токаревич, Д. В. Рублевский

В статье приведен обзор имеющихся данных об этиологии, ранней диагностике и лечении тесного положения постоянных нижних резцов в период смены зубов, представлены результаты собственных исследований по указанным проблемам. Научное обосновано влияние величины мезиодистального размера нижних вторых временных моляров на развитие тесного положения постоянных нижних резцов. Подтверждена эффективность разработанного метода прогнозирования величины мезиодистального размера непрорезавшихся постоянных клыков и премоляров у детей в период смены зубов. Проведен сравнительный анализ эффективности методов управления пространством в нижнем зубном ряду и обоснована целесообразность их использования в зависимости от выраженности дефицита места в зубной дуге.

Ключевые слова: тесное положение постоянных нижних резцов, смешанный прикус, прогнозирование размера зубов, управление пространством.