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Modified Dental Crowding Treatment Protocol during Mixed Dentition

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Annotation. Dentalcrowdinginmixeddentitionisone ofthemostcommonorthodonticpathologiesnowadays . According to modern literature database it's prevalence reaches 77% and present at all occlusion periods, which is a significant sign of malocclusion's severity. The aim of our research is to develop rational treatment protocol of patients with dental crowding during mixed dentition period according to facial skeleton growth patterns and also to make comparative analysis of treatment efficiency by using traditional and suggested protocol. Patients in mixed dentition period with dental crowding (n=164) were examined over a period of last three years at the base of NMU O.O. Bogomolets Dental Center, Kyiv. A total of 328 CBCT sections of facial skeleton (medium FOV) before and after treatment were submitted to the general analysis. The results and conclusions of treatment efficiency analysis were carried out by using the suggested protocol of dental crowding treatment with different facial skeleton growth patterns. Results indicated an improvement in treatment efficiency of this pathology and significant treatment time shortening.The results obtained after 16 months in patients with a horizontal growth pattern indicate that treatment efficiency value of clinical group (CG) II patients was 58.1±1.3%; after 17 months in patients with vertical and neutral growth patterns, treatment efficiency value of CG III was 66.7±1.6%, CG I - was 52.3±0.9%. The algorithm proposed by us allows to shorten treatment duration by 3-4 months.

Keywords:malocclusion, mixeddentition, growthpattern, facial skeleton, palatalexpansiontechnique.

I. INTRODUCTION.

Modern orthodontic literature database indicates a consistently high frequency of malocclusions and dentognathic deformities that appear in children and adolescents. A huge increase in their prevalence is observed in children during the mixed dentition stage, which reaches 80%.[1-3]. Moreover, the most common are class I malocclusions, which according to various authors range from 50.6% to 84.4%[1-3]. It is also scientifically proven that with age no self-regulation of dental crowding is observed and in 80-90% of all cases it's likely to be observed during the permanent dentition period[5,7]. Determination of facial skeleton growth pattern is of significant practical importance, as it allows to make the most optimal choice for treatment start, to choose correct treatment method, to predict treatment's duration and consequences[5,9]. Dental crowding is one of the most common issues of orthodontics nowadays. Accoeding to worldwide literatureit's prevalence reaches 77% [2,3,8] and present at all occlusion periods, which is a significant sign of malocclusion's severity. Literature describes many methods of dental crowding treatment during mixed dentition period, which is caused by both maxillary and mandibular constriction. The most modern is usage of Rapid Maxillary Expansion protocol (RME) with Marco-Rosa appliance [10,11]. While the advantages of this aplliance are well known and scientifically proven, this appliance doesn't allow to directly expand maxillary frontal area and to create enough amount of space for anterior dental crowding regulation. That's why a new appliance for dental crowding treatment during mixed dentition was suggested by us. It's not only transversally expanding constricted maxilla a but also equally expands maxillary frontal area (patent of Ukraine № 149170, 21.10.2021).

Aim of research. To develop rational treatment protocol of patients with dental crowding during mixed dentition period according to facial skeleton growth patterns and also to make comparative analysis of treatment efficiency based on cone-beamed computed tomography (CBCT) data by using traditional and suggested treatment protocol.

Materials and methods. For three years (2020-2022), we examined and treated patients with dental crowding at the Dental Medical Center of the Bogomolets National Medical University named. The research was carried out in compliance with the main provisions of the "Rules of Ethical Principles of Scientific Medical Research with Human Participation" approved by the Helsinki

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Declaration (1964-2013), ICH GCP (1996), EU Directive No. 609 (from November 24, 1986), orders of the Ministry of Health of Ukraine No. 690 dated September 23, 2009, No. 944 dated December 14, 2009, No. 616 dated August 3, 2012.All participants were informed about the purpose and methods of the study and signed an informed consent to participate in it, and all measures were taken to ensure patient anonymity. The criteria for randomization of patients were next: mixed dentition period (7-11 years), the presence of dental crowding in maxillary and/or mandibular frontal area, erupted first permanent molars, the absence of general somatic diseases. Research included 164 people, 64 (39.1%) patients were male, and 100 (60.9%) patients were female.The distribution of examined patients according to the facial skeleton growth pattern is shown in Table 1. According to the algorithm developed by us, all patients who entered the examination groups were subjected to diagnostics before and after treatment. A total of 328 CBCT slices of the facial skull (medium FOV) of the patients at the beginning and after the treatment were analyzed.On CBCT sliceswe evaluated changes in width of both maxilla and mandible at basal arches (in the projection of the first permanent molars between the most convex points of the cortical plate, departing from the enamel-cement junction by 8 mm in the direction of the apex of the root) and alveolar arches (in the projection of the first permanent molars between the most convex points of the alveolar process, receding from the enamel-cement junction by 3 mm in the direction of the apex of the root) levels before and after treatment, and changes of dental crowding severity were also evaluated according to the Little's IrregularityIndex values.

Table 1. Distribution of patients according to facial skeleton growth pattern and gender.

Growth pattern	Group of control, n= 20		Clinical groupI, n=44		Clinical group II, n=48		Clinical group III, n=52	
	male	female	male	female	male	female	male	female
horizontal	2	3	-	-	18	30	-	-
neutral	6	5	12	32	-	-	-	-
vertical	3	1	-	-	-	-	21	31

The generally accepted algorithm for dental crowding treatment is applying RME protocol has 2 phases, consisting fixation of Marco-Rosa appliance on maxilla and the activation of a 10 mm screw, once every 2 days at 90°, the active phase of screw activation is 64 days (2 months), after the end of the active phase this appliance remains in the oral cavity for 6 months as a retention . After the RME protocol, if necessary, a myofunctional trainer is additionally prescribed for 12 months with a wearing regime of 12 hours per day.

All patients had clinically significant dental crowding and were distributed into the clinical groups according to their facial skeleton growth patterns.

1. First clinical group – 44 patients(30,5%)
2. Second clinical group – 48 patients(33,3%)
3. Third clinical group – 52 patients(36,2%)

The first clinical group consisted of patients with a neutral type of growth of the bones of the facial skull, the second clinical group included patients with a vertical type of growth of the bones of the facial skull, and the third clinical group included patients with a horizontal type of growth of the bones of the facial skull.

The patients of each clinical group were treated according to our proposed algorithms: the first phase of orthodontic treatment consisted of suggested appliance fixationon maxillary dental arch with existing beams adjacent to the lateral group of teeth and protracting archesin the frontal area, together with a fixation of Williams fixed mandibular expander; the second phase consisted in prescription of myofunctional appliance depending on the presented malocclusion.

In the 1st clinical group, 30 people were treated according to the algorithm proposed by us: the appliance's screw proposed by us is activated once a day, the active phase is 32 days (1 month), fixed mandibular expanderby Williams is installed 2 weeks after the start of treatment and is activated once per 3 days, active phase - 1.5 months. Both devices remain in the oral cavity for a retention period of 6 months. After immediate removal of the devices, a myofunctional trainer is prescribed for 10 months: the mode of use is 14 hours a day, every day. The effectiveness of treatment was 52.3±0.9%, total duration of treatment was 17 months; 14 people were treated according to the standard algorithm: the screw of Marco-Rosa appliance is activated once per 2 days, the duration of the active phase of treatment is 64 days (2

months), the retention period is 6 months. After 3 weeks from the start of treatment, an installation of fixed mandibular expander byWilliams with an activation scheme once per 4 days, the duration of the active phase of treatment is 1.5 months, and the retention period is 5 months. After immediate removal of the devices, a myofunctional trainer is prescribed for 12 months. Mode of use: 12 hours a day. The effectiveness of treatment was 25.6±1.7%, the total duration of treatment was 20 months. Our proposed algorithm is more effective than the standard one in clinical group I patients by 26.9 ± 1.2%.

In the II clinical group, 36 people were treated according to the algorithm proposed by us: the appliance's screw proposed by us is activated once a day, the active phase is 32 days (1 month), fixed mandibular expander by Williams is installed 2 weeks after the start of treatment and is activated once per 3 days, active phase - 1.5 months. Both devices remain in the oral cavity for a retention period of 6 months. After immediate removal of the devices, a myofunctional trainer is prescribed for 9 months: the mode of use is 15 hours per day, every day. The effectiveness of the treatment was 58.1±1.7%, total duration of treatment was 16 months; 12 people were treated according to the standard algorithm: the screw of Marco-Rosa appliance is activated once per 2 days, the duration of the active phase of treatment is 64 days (2 months), the retention period is 6 months. After 3 weeks from the start of treatment, an installation of fixed mandibular expander by Williams with an activation scheme once per 4 days, the duration of the active phase of treatment is 1.5 months, and the retention period is 5 months. After immediate removal of the devices, a myofunctional trainer is prescribed for 12 months. Mode of use: 12 hours per day. The effectiveness of treatment was 22.3±2.1%, the total duration of treatment was 20 months. Our proposed algorithm is 35.8 ± 0.9% more effective than the standard one in clinical group II patients.

In the III clinical group, 30 people were treated according to the algorithm proposed by us: the appliance's screw proposed by us is activated once a day, the active phase is 32 days (1 month), fixed mandibular expander by Williams is installed 2 weeks after the start of treatment and is activated once per 3 days, active phase - 1.5 months. Both devices remain in the oral cavity for a retention period of 6 months. After immediate removal of the devices, a myofunctional trainer is prescribed for10 months: the mode of use is 14 hours per day, every day. The effectiveness of the treatment was 66.7±1.6%, the total duration of treatment was 17 months; 16 people were treated according to the standard algorithm: the screw of Marco-Rosa appliance is activated once per 2 days, the duration of the active phase of treatment is 64 days (2 months), the retention period is 6 months. After 3 weeks from the start of treatment, an installation of fixed mandibular expander by Williams with an activation scheme once per 4 days, the duration of the active phase of treatment is 1.5 months, and the retention period is 5 months. After immediate removal of the devices, a myofunctional trainer is prescribed for 12 months. Mode of use: 12 hours a day. The effectiveness of treatment was 29.5±2.4%, total duration of treatment was 20 months. Our proposed algorithm is 37.3 ±0.7% more effective than the standard one in patients of the III clinical group. The control group consisted of 20 people.

The data we received were analyzed, interpreted and statistically processed. Statistical processing of these data included a number of parametric and non-parametric criteria of statistical methods. The analysis was performed using statistical packages MedStat and EZR v. 1.35 (Saitama Medical Center, Jichi Medical University, Saitama, Japan 2017). Statistical analysis of materials, summarization of results, and generalization of conclusions were performed using the method of variational statistics, taking into account average values (mode, median, arithmetic mean) and average error (M) with evaluation of reliable values according to the Wilcoxon t-test, as well as with the determination of the correlation coefficient using the paired Pearson's method to identify relationships between the obtained indicators. A value of $p<0.05$ was taken as the minimum probability threshold.

To compare these indicators obtained before and after treatment, appropriate comparison criteria for related samples were used. Comparison of qualitative features was carried out using the Chi-square test. If more than two clinical groups were compared, univariate analysis of variance (if a normal distribution) or Kruskel–Wallis test (if a non-normal distribution) was used for quantitative indicators. During the statistical analysis, criteria with a two-sided critical area were used, with the critical level of significance being $p=0.05$.

II. RESULTS.

According to research results (**table 2**), it was established that when using the proposed protocol in CG 1, the skeletal effect of the maxillary expansion (BAMxW) is 4.8±1.1 mm, the alveolar effect of the expansion of maxilla (AAMxW) is 4.9±0.8 mm., expansion of mandible at the basal level (BAMdW) was 3.0±0.7 mm,

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while at the alveolar level (AAMdW) 5.9 ± 1.2 mm was reached; at the same time, we managed to reduce the Little's Irregularity Index value of upper teeth (LIIMx) by 12.2 ± 1.5 mm, the Little's Irregularity Index value of lower teeth(LIIMd)by 9.3 ± 0.8 mm, i.e., we were able to transfer the severity of crowding from severe to mild on both maxilla and mandible. The effectiveness of the treatment was 52.3±0.9%.

When using the proposed protocol in CG 2, the skeletal effect of the maxillaryexpansion (BAMxW) is4,8±0,6 mm, the alveolar effect of the expansion of maxilla(AAMxW) – 4,2±0,6 mm., expansion ofmandibleat the basal level (BAMdW) was 3,2 ±0,4 mm, while at the alveolar level (AAMdW) –4,1 ± 0,7 mm;at the same time, we managed to reduce the Little's Irregularity Index value of upper teeth (LIIMx) by 13,1 ± 1,2 mm, the Little's Irregularity Index value of lower teeth(LIIMd)by6,9±1,4 mm, i.e., we were able to transfer the severity of crowding from severe to mild on both maxilla and mandible. The effectiveness of the treatment was 58,1±1,7%.

When using the proposed protocol in CG 3, the skeletal effect of the maxillaryexpansion (BAMxW) is6,3±0,7 mm, the alveolar effect of the expansion of maxilla(AAMxW) – 5,2±0,9mm., expansion ofmandibleat the basal level (BAMdW) was 3,6 ±0,8 mm, while at the alveolar level (AAMdW) – 4,7 ± 1,1 mm;at the same time, we managed to reduce the Little's Irregularity Index value of upper teeth (LIIMx) by 11,9 ± 1,7 mm, the Little's Irregularity Index value of lower teeth(LIIMd)by6,9±1,4 mm, i.e., we were able to transfer the severity of maxillary crowding from severe to moderate, from severe to mild on mandible. The effectiveness of the treatment was 66,7±1,6%.

Table 2. CBCT data values in clinical groups by suggested protocol.

CBCT data	CGI			
	Before treatment	After treatment	Treatment efficiency	p-value
BAMxW	58,7 ±1,6 mm	62,1 ± 0,9 mm	52,3±0,9%	p<0,05
AAMxW	56,2 ± 2,3 mm	60,9 ± 1,3 mm		p<0,05
BAMdW	56,8 ± 1,2 mm	58,7 ± 0,6 mm		p<0,05
AAMdW	55,5 ± 2,1 mm	59,6 ± 1,4 mm		p<0,05
LIIMx	18,1±3,5 mm	6,4 ± 1,5 mm		p<0,05
LIIMd	13,9± 2,4 mm	4,6±3,2 mm		p<0,05
CBCT data	CGII			
	Before treatment	After treatment	Treatment efficiency	p-value
BAMxW	58,9 ±1,8 mm	63,2 ± 1,7 mm	58,1±1,7%	p<0,05
AAMxW	56,5± 2,1mm	61,4 ± 1,3 mm		p<0,05
BAMdW	57,1 ± 1,4 mm	59,4 ± 0,9 mm		p<0,05
AAMdW	55,9 ± 2,6 mm	60,8 ± 2,4 mm		p<0,05
LIIMx	17,8±2,9 mm	4,7 ± 1,8 mm		p<0,05
LIIMd	11,7± 2,5 mm	4,8±1,1 mm		p<0,05
CBCT data	CGIII			
	Before treatment	After treatment	Treatment efficiency	p-value
BAMxW	55,6 ±1,3 mm	62,7 ± 1,5 mm	66,7±1,6%	p<0,05
AAMxW	53,2 ± 2,5mm	58,9 ± 2,3 mm		p<0,05
BAMdW	54,8 ± 1,5 mm	58,7 ± 0,6 mm		p<0,05
AAMdW	55,2 ± 2,1 mm	57,5 ± 2,9 mm		p<0,05
LIIMx	18,1±3,5 mm	6,4 ± 1,5 mm		p<0,05
LIIMd	13,9± 2,4 mm	2,9±0,5 mm		p<0,05

Evaluating the results of treatment using a standard protocol, we found that in patients with neutralgrowththe skeletal effect of maxillaryexpansion was2,7±0,6 mm, alveolareffectofexpansionwas 2,4±0,8mm., the skeletal effect of mandibularexpansion was1,8±0,5mm, while at the alveolar level mandibular expansion was3,9 ± 0,8mm;at the same time, we managed to reduce the Little's Irregularity Index value of upper teeth by 5,8 ± 1,5 mm, at the

same time, we managed to reduce the Little's Irregularity Index value of lower teethby 4,3±0,5 mm, , i.e., we were able to transfer the severity degree of crowdingonly from severe to moderate on both maxilla and mandible. The effectiveness of the treatment was 25,6±1,7%.

Patients with horizontalgrowthhadlesser skeletal effect of maxillaryexpansion–2,5±0,8 mm, alveolareffectofexpansionwas3,6±1,3mm., the skeletal effect of mandibularexpansion was2,1±0,5mm, while at the alveolar levelmandibularexpansionwas2,8 ± 0,7mm;at the same time, we managed to reduce the Little's Irregularity Index value of upper teeth by 6,2 ± 1,4mm, we managed to reduce the Little's Irregularity Index value of lower teeth by 5,1±0,7 mm, were able to transfer the severity degree of crowdingfrom severe to moderate on both maxilla and mandible. The effectiveness of the treatment was22,3±2,1%.

Patients with verticalgrowthhadbetter skeletal effect of maxillaryexpansion–3,4±0,9 mm, alveolareffectofexpansionwas2,9±0,5mm., the skeletal effect of mandibularexpansion was 3,3±0,4mm, at the alveolar levelmandibularexpansionwas3,8 ± 1,3mm;at the same time, we managed to reduce the Little's Irregularity Index value of upper teeth by 4,2 ± 1,3mm, at the same time, we managed to reduce the Little's Irregularity Index value of lower teeth by 3,4±0,3 mm, were able to transfer the severity degree of crowdingfrom severe to moderate on both maxilla and mandible. The effectiveness of the treatment was29,5±2,4%.

III. DISCUSSION.

Comparing the obtained results of the effectiveness of the treatment with the results of the effectiveness of the treatment of tooth crowding in variable bite according to traditional methods[10, 11] a significant difference in quantitative data was observed.Thus, the effectiveness of treatment of patients of CG III reached 66.7±1.6% (for the results obtained from patients who were treated according to the traditional algorithm, this indicator was 29.5±2.4%); CG II - up to 58.1±1.3% (for the results obtained in patients who were treated according to the traditional algorithm, this indicator was 22.3±2.1%); CG I – 52.3±0.9% (for the results obtained in patients who were treated according to the traditional algorithm, this indicator was 25.6±1.7%).

Conclusions. The results of our conducted statistical analysis of the proposed protocol application efficiency of dental crowding treatment allowed to improve treatment qualityof this pathology in children. The results obtained after 16 months in patients with a horizontal type of growth indicate that the effectiveness of the treatment of CG II patients reached 58.1±1.3%; after 17 months, in patients with a vertical and neutral type of growth, the effectiveness of the treatment of CG III reached 66.7±1.6%, CG I - up to 52.3±0.9%.Our proposed algorithm is more effective in patients with a neutral type of growth by 26.9 ± 1.2%, in patients with a vertical type of growth by 37.3 ± 0.7% and allows to shorten their total treatment period by 3 months; more effective in patients with a horizontal type of growth by 35.8 ± 0.9% and allows to shorten their total treatment period by 4 months.

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A - Conception and design of the work, B - Data collection and analysis, C - Responsibility for the statistical analysis, D - Writing the article, E - Critical review, F - Final approval of the article

REFERENCES

[1]. Alhammadi, M. S., Halboub, E., Fayed, M. S., Labib, A., & El-Saaidi, C. (2018). Global distribution of malocclusion traits: A systematic review. Dental press journal of orthodontics, 23(6), 40.e1–40.e10. https://doi.org/10.1590/2177-6709.23.6.40.e1-10.onl

[2]. Дєньга, О. В. (2004). Поширеність зубощелепних аномалій і карієсу зубів у дітей у період раннього змінного прикусу. Український стоматологічний альманах, 1(2), 48-50.

[3]. Куроєдова, В. Д., & Дмитренко, М. І. (2008). Скупченість зубів.http://repository.pdmu.edu.ua:8080/bitstream/123456789/6377/1/Crowding.pdf

[4]. Proffit, W. R., Fields, H. W., Larson, B., & Sarver, D. M. (2018). Contemporary orthodontics-e-book. Elsevier Health Sciences.

[5]. Ronay, V., Miner, R. M., Will, L. A., & Arai, K. (2008). Mandibular arch form: the relationship between dental and basal anatomy. American journal of orthodontics and dentofacial orthopedics : official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics, 134(3), 430–438. https://doi.org/10.1016/j.ajodo.2006.10.040

[6]. Tanaka, M. M., & Johnston, L. E. (1974). The prediction of the size of unerupted canines and premolars in a contemporary orthodontic population. Journal of the American Dental Association (1939), 88(4), 798–801.

[7]. Sayin, M. O., & Türkkahraman, H. (2004). Factors contributing to mandibular anterior crowding in the early mixed dentition. The Angle orthodontist, 74(6), 754–758. https://doi.org/10.1043/0003-3219(2004)074<0754:FCTMAC>2.0.CO;2

[8]. Crossley, A. M., Campbell, P. M., Tadlock, L. P., Schneiderman, E., & Buschang, P. H. (2020). Is there a relationship between dental crowding and the size of the maxillary or mandibular apical base?. The Angle orthodontist, 90(2), 216–223. https://doi.org/10.2319/051019-324.1

[9]. Lombardo, G., Vena, F., Negri, P., Pagano, S., Barilotti, C., Paglia, L., Colombo, S., Orso, M., & Cianetti, S. (2020). Worldwide prevalence of malocclusion in the different stages of dentition: A systematic review and meta-analysis. European journal of paediatric dentistry, 21(2), 115–122. https://doi.org/10.23804/ejpd.2020.21.02.05

[10]. Caroccia, F., Moscagiuri, F., Falconio, L., Festa, F., & D'Attilio, M. (2020). Early Orthodontic Treatments of Unilateral Posterior Crossbite: A Systematic Review. Journal of clinical medicine, 10(1), 33. https://doi.org/10.3390/jcm10010033

[11]. Alsawaf, D. H., Almaasarani, S. G., Hajeer, M. Y., & Rajeh, N. (2022). The effectiveness of the early orthodontic correction of functional unilateral posterior crossbite in the mixed dentition period: a systematic review and meta-analysis. Progress in orthodontics, 23(1), 5.https://doi.org/10.1186/s40510-022-00398-4