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ABSTRACT

of the dissertation for the degree of Doctor of Science

OPTIMIZATION OF DIFFERENTIAL DIAGNOSTICS AND ORTHODONTIC TREATMENT METHODS OF DISTAL BYTE ANOMALIES IN CHILDREN

Speciality: 3226.01 “Dentistry”

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GENERAL DESCRIPTION OF THE RESEARCH

Relevance of the topic. Dentofacial anomalies have the leading position among actual problems of stomatology. The prevalence among population (30-70%), negative impact in some cases affecting the whole body and resulting in psychological distress determine the medical and social significance of this problem. Distal bite is the most prevalent among dentofacial system anomalies (10-12 %). The wide spread of distal bite and improvement of its orthodontic treatment and prevention methods are current actual issues [1,2,3,4].

The specific features that distinguish the distal bite from other dentofacial anomalies are the structure of the craniofacial skeleton, jaw correlation, thickness of soft tissue, mimic and masticatory muscular tension and etc. Distal bite causes the deterioration in facial aesthetics, pronunciation and masticatory functions. Studying the development peculiarities of such anomalies in children, as well as, improving orthodontic treatment methods allow to eliminate anatomic, functional and aesthetic shortcomings [5,6,7].

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Dental and skelatal factors play major role in the development of the distal bite. Distal bite anomaly of skeletal origin occurs as a result of protrusion of maxilla or retrusion of mandible. Depending on its origin, different types of activators, headgears, non-removable ortodontic devices are used for treatment of the distal bite anomaly. Activators forcebly keep mandibula in anterior occlusion position, causing tension in intra-articular fibers respectively, and adaptive changes take place in the articular fossa [8,9,10].

There are scientific discussions relating to age periods more effective for the treatment of distal bite anomaly. Some authors offer the treatment at early ages is more effective, while others consider the puberty is a more appropriate period. In a juvenile period, optimal treatment method of distal bite is performed by stimulating the growth of the mandible. The growth center for mandible is the cartilage tissue of the temporo-mandibular joint. It is possible to stimulate the growth of mandible by affecting the cartilage tissue using different activators [11,12,13].

There are certain shortcomings in application of the activators for treatment of distal bite anomaly. These are: efficiency of treatment with removable activator depends on a patient, a large area

[8]Clark W.J. Twin block functional therapy applications in dentofacial orthopaedics. 3rd edition. //– London: Jaypee Brothers Med. Ltd, – 2015. – p. 90.

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[12]Janson G. Treatment times of Class II malocclusion: four premolar and non-extraction protocols / G. Janson, D.P. Valarelli, F.P. Valarelli, [et al.] // Eur. J. Orthod, – 2012. № 34(2), – p. 182-187.

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in the oral cavity is occupied by the device, activator has negative impact on speech and taste, difficulty in using the device for patients breathing through mouth, etc.

Scientific research studies on distal bite treatment methods reveal that efficient treatment of the mixed type distal bite anomaly requires a special approach. It is essential to plan the treatment taking into account the etiology of the anomaly, teeth and jaws topography, masticatory and swallowing function, age and social status of the patient, etc.

Early prevention of distal bite can be ensured by prevention of etiological factors leading to stomatognatic changes and implementation of integrated measures. Timely treatment of deciduous teeth, organization of prevention of ENT diseases in children and a proper design of orthodontic appliances prevent the prevalence of distal bite. Especially non-professional orthodontic intervention, missing appropriate time for treatment may result in further complications of dentofacial anomaly and loss of confidence in orthodontic treatment. It is more difficult to retreat patients with the orthodontic treatment failure than the others. Negligence of dentists with regard to deciduous occlusion, mixed and permanent occlusion physiology leads to distal bite formation which requires more effort and a long-term treatment. For this reason, improvement of distal bite anomaly's diagnostic methods, timely application of integrated prevention ways and development of new treatment methods are of great importance.

Objects of the study: patients with distal bite anomalies, S-MP_{3cap} growth period, no pathology of the temporamandibular joint.

The aim of the study: to determine the characteristic features of distal bite anomalies of various forms, their differential diagnostics and aproper selection of orthodontic treatment methods for increasing the orthodontic treatment efficiency in children.

Research objectives:

1. Systematizing the peculiarities of distal bite anomalies of different type and differential diagnostic methods.
2. Modelling and prognozing the changes due to distal bite anomalies basing on cephalometric parameters.

3. Selecting modern treatment principles of distal bite anomaly.
4. Studying the impact on craniofacial complex applying different orthodontic appliances to treat distal bite anomalies.
5. Studying the impact on occlusion using different orthodontic devices to treat distal bite anomalies.
6. Determining the treatment methods` algorythm for different forms of distal bite anomalies.
7. Developing efficient distal bite anomaly treatment method and assessment of its eficacy.

Methods of the study. The research was carried out using modern complex methods, including clinical examinations, photometric, biometric, radiological and statistical research methods.

Main theses for defence:

- Differential diagnostics of different types of distal bite anomalies and facial profile changes caused by them.
- Contemporary treatment principles of distal bite anomalies.
- Impact of various orthodontic appliances used in the treatment of distal bite anomalies on the craniofacial complex.
- Treatment methods for different forms of distal bite anomalies.
- Development of effective treatment methods for distal bite anomalies.

Scientific novelty:

- the examination and differential diagnostic methods for different forms of distal bite anomalies were systematized.
- the choice of an optimal treatment method based on modelling the changes in the case of distal bite was proposed.
- a new effective distal bite orthodontic treatment method was developed.
- algorythm in orthodontic treatment methods for different distal bite anomalies was developed.

Practical significance of the research:

- determining more effective treatment methods comparing the data on impact of applying different devices for distal bite anomalies treatment with model, cephalometric and photo analyses contribute to ease the orthodontist`s work, decrease the relapses, comfort the patients and shorten the treatment period.

- by applying the new modified orthodontic devices, the duration of the treatment is shortened, the efficiency of controlling over maxillary and mandibular development is increased.
- sistematizing the examination and differential diagnostic methods of distal bite in children, developing the treatment algorythms and the successful outcomes of developing a new modified orthodontic device ensure the efficient rehabilitation of such patients.

Approbation of the research. Main thesis of the dissertation were presented at 86th Conference of European Orthodontic Society (Slovenia, 2010); 101st Conference of Federation Dental International (FDI) (Istanbul, 2013), 91st Conference of European Orthodontic Society (Warsaw, 2014), 102nd Conference of Federation Dental International (Dehli, 2014), XX International Stomatological Conference organized by Azerbaijan Stomatological Association (Baku, 2015), 92nd Conference of European Orthodontic Society (Stockholm, 2016), 10th Conference of World Cleft Lip and Palate Society (India, 2016), Scientific-Practical Conference "Topical Problems of Medicine-2018" dedicated to 100th Anniversary of Azerbaijan Republic's Day (Baku, 2018), 16th Conference of Turkish Orthodontic Society (İzmir, 2018), 107th Conference of Federation Dental International (San-Francisco, 2019), 95th Conference of European Orthodontic Society (Nice, 2019).

Materials of the disseration were discussed during extended meeting of Pediatric Dentistry Department and Departments of other stomatological specialties in Azerbaijan Medical University (protocol № 07, dated 07.03.2019); at the scientific seminar of the Approbation Commission under the Dissertation Board ED 2.05 AMU (protocol № 05, dated 24.05.2021).

Application of the research. The research outcomes are being used in the educational process at Pediatric Dentistry Department of Azerbaijan Medical University (AMU) and in the practical work of the dental clinic of AMU.

The name of the organization where the dissertation has been accomplished. The scientific work was carried out at the

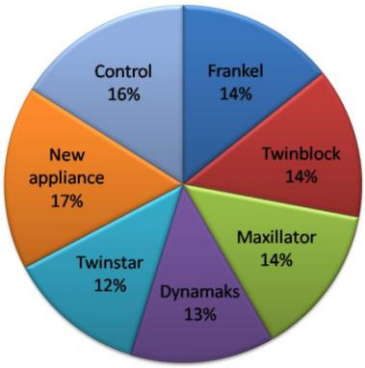
Department of Pediatric Dentistry of AMU and Dental Clinic of AMU.

Publications. 35 articles (13 abroad), 23 thesis, 1 patent, 2 textbooks and 3 methodic guidances have been published based on research material and outcomes.

Dissertation structure and volume. Dissertation consists of introduction, literature review (67884 characters), research material and methods (24111 characters), 3 chapters reflecting personal results (III chapter-71407, IV chapter -102846, V chapter -57115 characters), summary (66340 characters), results, practical recommendations and references, a total of 411826 characters, illustrated with 33 tables and 77 figures. Reference list consists of 393 sources.

MATERIAL AND METHODS.

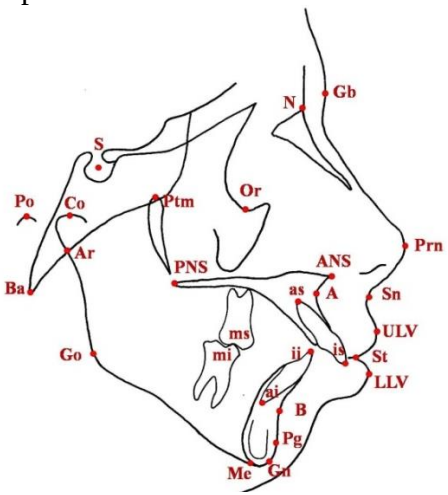
168 patients with distal bite aged 10-14 years were included in the study. 27 of them were in control group, 141 patients were treated by different orthodontic appliances. Patients were divided into 6 groups relevant to treatment appliances: 1st-Frankel (24 patients), 2nd-twinblock (23 patients), 3rd-our modified activators (28 patients), 4th-dynamax (22 patients), 5th-twinstar (21 patients), 6th-maxillator activator (23 patients) (Picture 1.).



Picture 1. Control and treatment groups

All patients had undergone pre- and post treatment clinical, model, X-ray (cephalometric, panoramic, hand-wrist, TMJ), biometric examinations, extraoral and intraoral photos were analyzed. Clinical examination had done in the following stages: interviewing, facial and oral cavity examination. Data on interviewing the patient included subjective complaints, similar anomalies of the patient`s relatives, diseases of mother during pregnancy, birth traumas, diet, harmfull habits, previous diseases. The study included the distal bite patients with Angle Class II relation of right and left molars, without TMJ pathology and previously not getting orthodontic treatment.

Cephalometric roentgenograms were analyzed to diagnose a distal bite in children, to differentiate and assess the peculiarities of stomatognatic system, growth and development, as well as the changes due to orthodontic treatment impact. Changes in both maxillary and mandibular bone and in occlusion and soft tissue were assessed by 45 cephalometric parameters. The determine the treatment efficiency main (treated) group was compared with the control (untreated) group. Cephalometric examinations in control group were used to reveal the development and growth peculiarities of the cranio-facial complex in children with distal bite. All cephalometric points used for the study are reflected in the picture 2.



Picture 2. Cephalometric points used in the study.

To determine the patients` growth stages, hand-wrist X-rays were used. The assessment for $PP_{2=}$, $MP_{3=}$, S, MP_{3cap}, DP_{3u}, PP_{3u}, MP_{3u}, Ru stages relevantly was done according to the level of ossificatioin of hand phalangs. Patients in S and MP_{3cap} stages were included in the research, for these stages being the pre-puberty and puberty stage (Picture 3).

Picture 3. S and MP_{3cap} stages on X-ray of a hand-wrist.

Patients' occlusion was assessed on plaster models, including intra-arch analyses. To ensure comparative observation of diagnostics and the course of the treatment, intra and extraoral photoes taken before, during and after the orthodontic treatment were compared.

The research was performed at University Stomatological Clinic of the Azerbaijan Medical University, Department of Pediatric Stomatology.

Personally modified twinblock activators were used as a new treatment method. Unlike twinblock (bended 70˚ forward), the apparatus we suggest is designed with the inclined plane, bended 60˚ backward (Picture 4). The purpose of posterior-superior regulation of the inclined plane is to prevent the forced forward mandibular to slide back.


Picture 4. Modified activator: frontal and lateral view.

For the device we modified, the forced occlusion position required was the mouth open 4-5 mm vertically and the mandible 3-4 mm posterior than maximum anterior position in sagital direction. This device, unlike twinblock, does not require to determine physiological relaxation condition and consider the height, as the contact of acrilic cuffs lying backward in mandible and forward in maxilla prevent the mandible to open and slide backward. In some types of distal bites, for additional sagital activation, the 60˚angle of the device can be extended up 90˚ position. This changes mostly provides the frontal fixation of the mandible. The main advantage of this activator is its usage during night time. Unnecessity to use it daytime makes the children more confident and ensure comfort during eating and speaking.

Statistical processing of results. Mean arithmentic value (M), standard deviation (σ), variation range (min-max) were evaluated statistically according to groups to characterize the research result values. These calculations were based on pre and post-treatment values, as well as on variation values; among sexual groups the calculation was done before and after the treatment. Variance analysis, Duncan test and Student-t test were also applied in the study.

RESULTS AND DISCUSSIONS

Craniofacial characteristics of distal bite. Hard and soft tissues changes and occlusion relations should be studied based on clinical, x-ray, cephalometric, photometric and model analyses to make a differential diagnosis of different forms of distal bite anomalies in children. This makes cranio-facial characteristics, cephalometric analysis of distal bite very important.

To study changes in anterior cranial base the S-N length parameter was used. This parameter was 67.05±6.96 for girls and 67.21±7.25 mm for boys, which is not statistically significant for comparison. It was proven that during distal bite cranial base length for boys and girls are similar. Cranial base inclination angle, NSAr, is 127.14±7.65 for girls and 127.67±7.37 for boys. Normally NSAr angle value is 123±5°. Less than normal angle value indicates anterior than normal position of TMJ in craniofacial complex, whereas more than normal angle value indicates TMJ posterior position. Though it was stated that in case of distal bite TMJ sometimes is located posterior to cranial base, no parameter deviation is observed in our study.

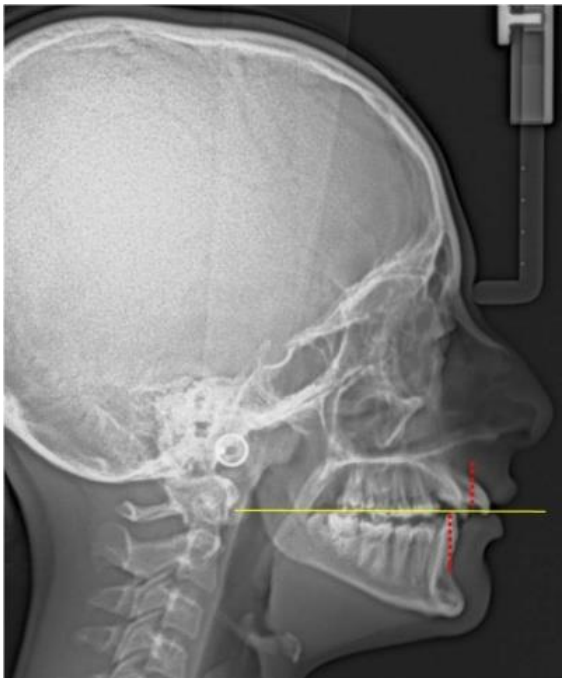
Mean arithmetic value of sagital length of maxilla (ANS-PNS) is 57.46±5.33 mm for girls and 57.69±4.86 mm for boys. Statistically not significant value of ANS-PNS parameter in the groups denotes the sagital value approximation of maxilla both for boys and girls. Though during distal bite anomaly, comparing to the value of individuals with normal occlusion, maxillary bone is longer, this value is determined to be appropriate in our study. In Steiner analysis, the sagital position of maxilla relative to the cranial base is determined by the SNA angle, which has normal value of 82±2°. While examining the children, mean arithmetic value of the angle was 80.45±3.63° for girls; 80.84±3.08° for boys; the value being within the norm range. Normal sagital position of maxilla was observed over the course of the study. The other parameter, used to determine the position of maxilla relative to cranio-facial complex was proposed by McNamara as a sagital distance between the point A and a line from point N perpedicular to the Frankfort horisontal

line (A-N perpendiculyar FH). If no pathology, point A is either right on the line or 1 mm away. For the examined subjects with distal bite, the mean arithmetic value of A-N perp FH for girls was 0.87±3.26 mm, with 0.14±3.53 mm for boys. Using different methods of sagital direction assessment, maxilla was revealed to have the normal position during the distal bite, as in children with normal occlusion.

Mean value of Pg-N perpr FH, reflecting the sagital position of mandible relative to cranio-facial complex for girls was -7.74±6.20 mm and -9.00±4.71 mm for boys. This parameter being less than normal manifests that the posterior location of mandible is a leading factor in formation of distal bite pathology. Co-Gn line, reflecting the mandibular length, is of mean arithmetic value in 104.30±8.13 mm for girls and 105.76±9.34 mm for boys. In 12-14 years children with normal occlusion Co-Gn value is usually within 120-130 mm, whereas in distal bite cases, its shortening is observed. The mandibular ramus height, the Ar-Go, has mean arithmetic value of 43.04±4.85 mm for girls and 43.57±4.73 mm for boys. There was no statistical significant in mean arithmetic values for boys' and girls' groups (p=0,516). If normally its value is more than 45 mm, it becomes obvious that during distal bite the vertical size of mandibular ramus also is getting smaller. Another parameter for the mandibular sagital location is SNB angle, normally being of 80^o value. In examined children, it is revealed to be 74.09 ± 3.41^o for girls, 74.64 ± 3.19^o for boys. The angle value is smaller that normal, which is the evidence of posterior location of mandible. The outcomes of the study testify that the cause of distal bite anomalies is the smaller than normal size and the posterior position of the mandible. The mean arithmetic value of SN/GoGn for the vertical position of mandible in skull skeleton is 34.24 ± 5.23^o for girls and 33.10 ± 4.46^o for boys. Gonial angle's normal value is within $125\text{-}137^o$ range. In examined children with distal bite, the mean arythmetic value is 126.50 ± 7.31^o for girls and 127.14 ± 9.13^o for boys. In children with distal bite the ML/FH angle mean arythmetic value was 24.55 ± 6.32^o for girls and for boys 23.76 ± 4.95^o. Palatal line (PL) and mandibular body line (ML) angle mean value is stated to be 24^o normally. The mean arythmetic value of this angle in examined children with distal

bite was 24.62±4.73º for girls and 24.29±4.95º for boys. Parameter mean value for boys and girls is not statistically significant (p=0,693). No deviation in parameters used to determine vertical problems testifies that there is no pathology in palatal plane and vertical direction of the mandibular inclination.

One of parameters used to determine sagital relations of jaws, is proposed by A.Jacobson, Wits measure, which is normally 0. Wits mean arythmetic value in children with distal bite involved in our study was 5.43±2.48 mm for girls and 5.62±2.35 mm for boys. This change reflects anterior position of maxilla and posterior position of mandible (Picture 5). Another parameter, ANB angle mean arythmetic value was 7.41±8.25º for girls and 6.18±2.01º for boys. Taking into account that the parameter values for maxillary sagital position are normal, it becomes obvious that discrepancy originates from mandible.



Picture 5. Wits parameter extension

Using the Co-A distance as an maxilla measurement, the sagital length comparison of maxilla and mandible was made. Co-A mean arythmetic value for girls was 83.79±6.36 mm and 85.68±7.40 mm for boys. The comparison of Co-A and Co-Gn parameters is more informative. In our study Co-A was approximately 84 mm for girls. According to the norm scale when Co-A is 84 mm, Co-Gn is expected to be 104-107 mm whereas the finding in our study was 104 mm. Co-A distance was 86 mm for boys, whereas if, according to the norm scale Co-A is 86 mm, Co-Gn is expected to be 107-110 mm and the finding was 105 mm. The comparative analysis revealed that the effective length of mandible is shorter than the maxilla.

To assess the inclination of the upper incisors during distal bite, upper incisor-NA angle, upper incisor-NA distance, upper incisor A-FH perpendicular distance, upper incisor-PL angle and upper incisor-SN angle parameters were used. The upper incisor-NA angle was 25.70±6.93º for girls and 26.85±5.96º for boys. Upper incisor-NA distance was 5.07±2.39 mm for girls and 5.67±2.14 mm for boys. Both parameters, supporting each other, manifested some minor protrusion of upper incisors. The angle between the upper incisors and palatal line was 118.51±8.21º for girls and 117.69±8.24º for boys, reflecting the protrusion of upper incisors.

Lower incisors' torque is determined by analyzing the lower incisor-NB angle, lower incisor-NB distance, lower incisor A-Pg distance, Pg-NB distance, Holdway difference, lower incisor-ML angle parameters. Lower incisor-NB angle was 25.83±6.43º for girls and 25.52±5.95º for boys, lower incisor-NB distance was 4.58±1.63 mm for girls and 4.44±1.20 mm for boys. Both indicators indicate that in children with distal bite lower incisors' inclination values are closer to those of children with normal occlussion and no statistic significant was determined between boys and girls. Lower incisor A-Pg distance, being 1.10±2.68 mm for girls and 0.92±3.26 mm for boys, supported other indicators. Lower incisor-ML angle was 96.08±9.13º for girls and 96.60±6.37º for boys, showing lower incisors being torqueed forwards relatively to the mandibular body. Holdway difference is expected to be zero for proper harmony, whereas we detected it to be 2.21±2.84 mm in girls and 1.42±2.70

mm in boys. According to this parameter either, lower incisors are located 2 mm forward in relation to their bone basis.

According to our observations, the occlusive change in distal bite is the most noticeable in relation between the crowns of incisors. The distance between the edges of upper incisors and lower incisal crowns in sagittal direction was 8.50±2.56 mm for girls and 8.22±2.45 mm for boys. When distance between the upper and lower incisors is more than 8 mm, it leads to loss of contact between them. In patients with bigger sagittal distance between incisors, narrowing of dental archs in transversal direction is noted. The growth of sagittal gap between upper and lower incisors is mostly accompanied by a vertical relation between incisors. Vertical distance between incisors was 4.46±1.73 mm for girls and 4.71±2.25 mm for boys.

To assess the vertical changes of skull skeleton we used N-ANS, ANS-Me, N-Me, S-Go parameters and Jarabak analysis. N-ANS parameter's mean arithmetic value was 55.51±6.93 mm for girls and 55.75±7.42 mm for boys. Absence of statistic reliability for N-ANS between groups denotes the average face height values to be similar for boys and girls. ANS-Me distance was 62.85±5.63 mm for girls and 61.80±6.86 mm for boys. The N-Me parameters, used to determine general face height was 111.35±8.20 mm for girls and 111.70±9.62 mm for boys. Growth of lower face height adds the overall face height. Results show that children with distal bite have long face in vertical plane. The reason for that is narrowing of maxilla in transversal direction and being high in vertical direction. Our examinations through the study revealed the higher instances of the long face among subjects with breathing difficulty through nose and breathing through mouth.

To determine upper lip changes during distal bite, distance between upper lip and E line, nasolabial and upper lip N-FH perpendicular angle parameters were used. Upper lip-E distance was 1.13±2.46 for girls and 0.96±2.62 for boys. Vermilion was slightly forward from norm (zero) in sagittal direction. Nasolabial angle is 94-110^{o} in case of normal occlusion. During distal bite, this angle becomes 118.73±13.64^{o} in boys and 119.12±11.63^{o} for girls, which is more than norm. Upper lip N-FH perpendicular for boys is

10.17±6.54º and 9.63±5.11º for girls. Our observations showed that patients with upper lip forward tendency have upper incisors' protrusion.

Distance from lower lip to E line is 1.00±2.68 mm for girls and 0.68±2.59 mm for boys. Both groups manifested a slight torque of lower lip forward (normally should be 0). In case of distal bite symphysis is located posteriorly, pulling the soft tissue back. That is why lower lip looks located posteriorly. In some patients lower lip becomes folded being squeezed by upper lip. This causes its vermilion torqueed forward. Labiomental angle for girls is 116.28±22.96º and 111.10±24.96º for boys. To ensure aesthetic optimum this angle is expected to be within the range of 110-130º. During normal occlusion in case of physiological relaxation upper lip touches the lower one. We found that distal bite in most cases disturbs this physiological condition. According to our calculations, during relative physiological relaxation, there is a distance of 3.66±3.09 mm for girls and 2.32±2.36 mm for boys between upper and lower lips.

Comparative characteristics of different treatment methods. Timely choosing the right method of treatment followed by differential diagnostics of distal bite is of great importance. Treatment may be effective in the case when the body is in growing and developing period. From this perspective, the comparative analysis of the outcomes in implementing different orthodontic devices for the treatment of distal bite and the results of our proposed treatment show that activators influence midface and skull skeleton. In the group treated by Frankel activators, frontal part of skull base length (S-N) changed for 0.77±1.14 mm, in twinblock group the change was 1.15±0.56 mm over the period of treatment, which is statistically significant ($p<0,001$). In the group of modified device, the skull base growth was noted to be 2.34±1.10 mm, in dynamax group 1.96±0.57 mm. In twinstar group the change in skull base length was 1.15±1.28 mm, being statistically significant ($p<0,001$). In maxillator group S-N increase was 2.28±1.67 mm ($p<0,001$). In the control group due to normal growth and development, the skull

base length value increase for 1.68±0.84 mm. Control group change is also statistically significant (p<0,001). Among devices used for distal bite treatment, our proposed modified orthodontic device had the most effective impact on the skull base growth. This device locally provides the normalization of sagital maxillo-mandibular relations. NSAr angle was increased in Frankel (1.55±2.95), modified activator (1.55±3.53) and Dynamax (1.28±3.86) groups and it was decreased in other groups. The growth indicators in both modified device and Frankel groups were similar. Angle increase is due to downward dislocation of mandible and apposition of posterior edge of the mandibular ramus. From this perspective our proposed modified device and Frankel device were most efficient in treatment.

Maxilla had sagittal growth in all groups. In Frankel device group ANS-PNS distance increased 0.69±1.67 mm, which is the least comparing with other groups (Table 1). The maximal increase in this parameter was noted in modified device (2.66±1.07 mm) and in maxillator group (2.66±1.57 mm) (p<0,001). Control group outcome was 2.26±2.3 mm which is statistically significant (p<0,01).

SNA angle value in Frankel group before and after treatment was 78.59±2.82^{o} and 78.77±2.99 respectively. Over the period of treatment the angle extension was 0.18±1.02^{o}. Twinblock treatment group initially had the angle of 82.43±3.19^{o}, decreasing to 82.14±3.23^{o} after the treatment. Under the treatment the angle reduced for 0.29±1.02^{o}. In the twinblock group the negative parameter change results from bone resorption. In the modified device group increase in angle was for 1.00±1.21^{o}, the change being from 82.68±2.31^{o} to 83.67±2.92^{o}. The angle growth occurred as a result of torque of upper maxillary incisors due to treatment by the modified device. These teeth torqueed forward and caused the thickening of periosteum. Periosteum thickening restored the upper lip esthetic appearance. In Dynamax treatment group SNA angle initially was 78.26±2.74^{o} and after treatment, 78.66±2.77^{o}. In the Twinstar group the parameter showed very little change. Thus initially, 81.95±3.17^{o}, then it became 82.04±3.45^{o}. This group's parameter change was 0.09±0.99^{o}, being statistically not significant. Under the influence of maxillator, the angle had increased to

0.45±0.93º changing from 79.73±3.00º to 80.19±3.18º. The pre and post data in maxillator group are not statistically significant. In nontreated group, the SNA parameter had increased to 0.36±1.33º under normal development. In control group angle increase was due to periosteum thickening of anterior maxillary surface. S-N plane with various inclination was revealed in some patients and it should be assessed as the main factor affecting the SNA angle value.

Table 1.

Maxillar measurements

Cephalometric parameters	Orthodontic appliances	Before treatment	After treatment	Difference	p
		M±σ	M±σ	M±σ	
ANS-PNS	Frankel	57,15±3,01	57,84±3,18	0,69±1,67	
	Tvinblock	58,41±3,64	59,34±4,70	0,93±1,94	*
	Mod. Twinblock	52,38±4,99	55,04±5,31	2,66±1,07	***
	Dynamaks	60,88±4,10	63,03±4,37	2,16±0,76	***
	Twin-star	61,64±5,06	62,71±5,08	1,07±0,86	***
	Maxillator	60,86±5,48	63,52±5,52	2,66±1,57	***
	Control	54,57±2,85	56,83±2,76	2,26±2,3	**
SNA	Frankel	78,59±2,82	78,77±2,99	0,18±1,02	
	Twinblock	82,43±3,19	82,14±3,23	-0,29±1,02	
	Mod. Twinblock	82,68±2,31	83,67±2,92	1,00±1,21	**
	Dynamax	78,26±2,74	78,66±2,77	0,41±1,37	
	Twin-star	81,95±3,17	82,04±3,45	0,09±0,99	
	Maxillator	79,73±3,00	80,19±3,18	0,45±0,93	
	Control	81,38±3,50	81,74±3,27	0,36±1,33	
A-N perp FH	Frankel	0,35±3,44	1,77±3,07	1,42±1,71	**
	Twinblock	0,58±2,13	0,62±1,92	0,04±1,09	
	Mod. Twinblock	0,42±2,44	0,68±2,28	0,27±1,16	
	Dynamax	-2,40±3,58	-1,81±3,30	0,59±1,85	
	Twin-star	1,43±3,14	0,57±3,76	-0,87±2,29	
	Maxillator	-1,82±3,43	-0,60±3,90	1,22±2,04	*
	Control	2,80±2,60	2,49±2,65	-0,31±0,99	

* - p<0,05 ** - p<0,01 *** - p<0,001

In patients with more parallel to ground S-N plane the SNA angle was marked to be bigger while the others, with vertical S-N plane had the small SNA angle. Point A is anatomically located on vestibular side of the upper incisors. The upper incisors` roots placement affects the A point sagittal position. In distal bite A point has a backward location caused by upper incisors` protrusion and SNA angle appears to have less value than required.

In the Frankel treatment group the frontal surface of maxilla, comparing to the Frankfort horizontal plane (A-N perp FH) dislocated forward 1.42±1.71 mm ($p<0,01$). In the Twinblock group the parameter change was 0.04±1.09 mm which is not statistically significant. Modified device group parameter change value was 0.27±1.16 mm. During Dynamax treatment groupe this parameter had increased 0.59±1.85 mm. Contrary to this groups, Twinstar group showed parameter decrease. It was determined that decrease in parameter was due to palate root torque of upper incisors. Maxillator treatment group had maxilla slide forward by 1.22±2.04 mm ($p<0,05$). In control group parameter change was 0.31±0.99 mm, which is not statistically significant. Cephalometric analyses revealed that the increase in maxillary length did not affect its sagittal position. Results show that our proposed treatment method is effective to slowdown the development of maxilla.

During preliminary examination all groups had SNB angle less than norm (80°) (Table 2). Under the influence of Frankel activator, this angle being initially 72.58±2.81° then increased to 75.34±2.73. Mandibula moved 2.77±1.31° forward and this is statistically significant ($p<0,001$). In Twinblock group the angle of 75.54±3.15° had increased to 1.25±1.39° over the course of orthodontic treatment and reached the level of 76.79±3.24°. Applying the modified device the SNB angle had increased to 3.69±1.01°, which is more than in other groups ($p<0,001$). In other groups, the apparatus was used all day long except meal times. Despite the fact that the modified device had been used only at night, we achieved a better result. In Dynamax group the SNB angle was 72,90±2,87 and 75,51±2,75 degree before and after treatment respectively.

Table 2.

Mandibular measurements

Cephalometric parameters	Orthodontic appliances	Before treatment	After treatment	Difference	p
		M±σ	M±σ	M±σ	
SNB	Frankel	72,58±2,81	75,34±2,73	2,77±1,31	***
	Twinblock	75,54±3,15	76,79±3,24	1,25±1,39	**
	Mod. Twinblock	75,41±2,79	79,10±2,46	3,69±1,01	***
	Dynamax	72,90±2,87	75,51±2,75	2,61±1,25	***
	Twin-star	75,73±2,61	78,54±3,36	2,80±2,00	***
	Maxillator	71,92±3,32	75,17±2,91	3,25±1,72	***
	Control	76,00±2,83	76,81±3,26	0,80±1,25	*
Pg-N perp FH	Frankel	-10,10±8,09	-4,53±8,23	5,57±1,60	***
	Twinblock	-6,88±3,35	-1,88±4,05	5,00±1,42	***
	Mod. Twinblock	-10,27±2,62	-6,68±2,97	3,59±1,57	***
	Dynamax	-9,91±5,29	-6,64±4,90	3,27±2,12	***
	Twin-star	-6,20±7,24	-2,99±7,37	3,21±4,96	*
	Maxillator	-12,48±3,33	-9,09±4,26	3,40±2,41	***
	Control	-4,72±4,70	-4,1±5,22	0,54±1,18	
Co-Gn	Frankel	110,03±5,63	113,88±5,82	3,85±3,64	***
	Twinblock	110,00±8,40	113,70±9,33	3,70±2,49	***
	Mod. Twinblock	93,10±4,09	96,67±4,87	3,57±1,77	***
	Dynamax	109,35±6,10	112,61±6,01	3,26±3,30	**
	Twin-star	99,00±4,50	103,26±6,20	4,26±3,95	***
	Maxillator	99,30±7,05	103,02±6,30	4,73±4,59	***
	Control	111,84±5,67	116,06±5,34	4,22±2,58	***

* - p<0,05 ** - p<0,01 *** - p<0,001

Applying the Twinstar apparatus, the forward displacement of the jaw was 2,80±2,00 degree (p<0,001). In Twinstar group, the SNB angle was 75,73±2,61 and 78,54±3,36 degrees before and after treatment, respectively. Under the influence of the maxillator apparatus, the SNB angle reached from 71,92±3,32 degree to 75,17±2,91 degree. It has been known that there is a 3,25±1,72 degree angle growth as a result of an effect of this apparatus (p<0,001). In the control group, forward displacement of jaw was 0.80±1.25 degree.

The most prominent forward displacement in the jaw bone was caused by the influence of our apparatus. The most effective method in the treatment of distal bite is the application of the device that we offered in terms of the jaw displacement. Depending on the degree of mandibulary displacement the profile of patients has different variability. Possibility of not using the proposed activator in daytime provides the normal chewing and pronunciation functions and additionally, the forward displacement of the jaw bone.

The forward displacement of the jaw occurs as a result of acceleration of growth processes in the cartilage of the TMJ. Considering the fact that the growth hormones are at the highest titration level in the blood at night, the apparatus was used only at night by the patients. According to the study results, without the use of the activator in the daytime, it is possible to affect the growth of the jawbone and joint cartilage. The time for the use of new orthodontic apparatus was 8-12 hours daily. To promote the growth of cartilage in the joint head of the jawbone, certain hours of the day are sufficient to influence it. Repeated clinical records were made 3-6 months after leaving the orthodontic apparatus. It was found that the results obtained in the sagittal distance between the incisors and the profile remained stable during this time. The stability of the obtained occlusion indicates that bone displacement became adapted to function. Masticatory and mimic muscles have shown appropriate adaptive changes to the new place of the mandible.

Since the Pogonion point is located on the frontal surface of the jaw bone, the displacement of this point indicates the sagittal position of the mandibula. In the group we treated with the Frankel apparatus, Pg-N perp FH distance was -10,10±8.09 mm before treatment, then -4.53±8,23 mm. According to this parameter, the displacement of the jawbone by the influence of the Frankel apparatus was 5,57±1,60 mm. The comparison of values before and after treatment was statistically significant ($p<0,001$). In Twinblock group, the parameter changed from -6,88±3,35 mm to -1,88±4,05 mm. The change in the parameter was 5,00±1,42 mm. In modified apparatus group, the jawbone is located more distally before the treatment. Thus, the parameter of Pg-N perp FH was -10,27±2,62 mm before treatment.

With treatment, the jawbone moved forward 3,59±1,57 mm and eventually, parameter was -6,68±2,97 mm. The comparison of the values of the parameter before and after treatment was statistically significant ($p<0,001$). Though the activator we offered, was used only at night, like a traditional activator, it forced the jawbone to move forward. The pre-treatment value of Pg-N perp FH in the Dynamax group was -9,91±5,29 mm, the post-treatment value was -6,64±4,90 mm. Under the influence of Dynamax, displacement of the jawbone was 3,27±2,12 mm ($p<0,001$). In the Twinstar group, the parameter Pg-N perp FH was -6,20±7,24 mm before, then -2,99±7,37 mm. The smaller change occurs with treatment in this group than in other groups ($p<0.05$). In the group we treated with the maxillator, the average cost of the parameter was -12,48±3,33 mm pre-treatment and post treatment, -9,09±4,26 mm. Displacement of the jaw bone by the influence of the maxillator was 3.40±2.41 mm, which was statistically significant ($p<0.001$). For untreated patients, the amount of change during the control period was 0.54±1.18 mm. The comparison of the previous and subsequent values of this parameter in the control group is not statistically significant. In all treatment groups, the main forward displacement of the mandible was realized.

A patient R.E. has been diagnozed with distal dental anomaly of skeletal and dental origin. Aged 11,2 chronological years and 12 bone-years patient`s main complaint is the position the mandible posterior to the midface due to poor development. Due to the folding of the lower lip, the labiomental angle is narrowed, a convex profile is formed (Picture 6). According to the results of the cephalometric analysis, the SNB angle is 74 degree which indicates the distal location of the mandible. For the treatment of distal bite anomaly, our modified orthodontic apparatus was used. In addition to speeding up the forward development of the mandible with the activator, part of the upper apparatus, which contacts the lower masticatory teeth, was eroded to ensure a free space necessary for the development of these teeth in a vertical direction. With the mandible moving forward, the aesthetic appearance of soft tissues, profile and mouth structure has been restored.

a b

Picture 6. Patient R.E.: a-before treatment, b-after the treatment

Co-Gn, the total length indicator of the mandible, had increased in the treatment and control groups. In the group, treated with the Frankel apparatus, the length was 110.03±5,63 mm before treatment and 113,88±5,82 mm after treatment. During the treatment period, the mandible growth is estimated by 3,85±3,64 mm, which is statistically significant ($p<0,001$). Growth value caused by the action of the Twinblock apparatus is close to the value in Frankel apparatus treatment group. Co-Gn indicator being 110,00±8,40 mm before treatment, became 113,70±9,33 mm after Twinblock apparatus treatment. Co-Gn length increased by 3,70±2,49 mm during Twinblock use ($p<0,001$). The change in the group treated with the modified activator was also 3,57±1,77 mm, which is close to the change treated by two other devices. In the group of Dynamax, Co-Gn was initially 109,35±6,10 mm, then 112,61±6,01 mm. The variation between the previous and subsequent values was 3,26±3,30 mm ($p<0,01$). During the treatment with the Twinstar apparatus, the total length of the jawbone increased by 4,26±3,95 mm, from 99,00±4,50 mm to 103,26±6,20 mm. The difference in this group has also been statistically significant. In the group treated by the maxillator, the parameter increased from 99.30±7,05 mm to 103,02±6,30 mm. The difference in pre and post treatment values was stated to be 4,73±4,59 mm. In the control group, the length of

the mandible increased in size close to the treatment groups. Thus, the difference in the pre-and post parameter value was 4,22±2,58 mm. It is identified that the length of the mandible increases appropriate to the normal growth pattern, under the influence of the activators used for distal bite treatment and the apparatus we have modified. The intermaxillary sagittal discrepancy is corrected due to forward displacement of the mandible.

In the treatment of distal bite, the forward displacement of mandible is accompanied by posterior-inferior rotation. With the effect of the Frankel apparatus, we detected that the mandible could rotate 1,98±1,95 degree in the posterior-inferior direction. In this group, the SN/GoGn angle was 33,32±5,42 degree before treatment, then 35,30±5,64 degree ($p<0,01$). Under the influence of the Twinblock apparatus, there was little change in the vertical position of the jawbone. In this group, the angle was previously 33,66±3,93 degree, then 33,79±3,77 degree. The angle with the effect of the modified apparatus increased in size 1,96±2,02. In this group, the parameter was previously 33,51±4,82 degree, then 35,47±5,23 degree ($p<0,01$). With the effect of the Dynamax apparatus, the SN/GoGn angle has increased from 33,83±6,45 degree to 34,97±7,37 degree. The difference here is 1,14±2,61 degree, which is not statistically significant. Twinstar treatment group has shown very little change in parameter. Here, the angle value increased from 31,62±5,03 by adding 0,25±1,99 degree, eventually reaching 31,87±5,44 degree. Using this method of treatment, very little vertical change in the jawbone has been noted. During treatment with the maxillator apparatus, the anterior-superior rotation of the mandible had been accessible. The angle, initially being of 36,67±4,18 degree, during the treatment course reduced by 1,56±3,09 degree subsequently becoming 35,12±3,98 degree. In untreated patients, this parameter was found to be reduced by 1,54±2,03 degrees. As a result of bone resorption at the inferior edge of the mandibular body anterior segment, the angle decrease was stated in the maxillator and control groups. The highest indicators were obtained as a result of the treatment with the Frankel and the modified apparatus offered. It is determined that by applying these

two treatment methods periosteum development parallel with the mandibular displacement may be achieved.

Normalization of the mandibular-maxillary sagittal relations is very important indicator in the distal bite treatment. In distal bite treatment, the effect of orthodontic devices on the mandibular and maxillary bones` sagittal relationship in the occlusion plane is revealed by the reduction of the Wits parameter. As a result of treatment with the Frankel apparatus, the Wits parameter decrease in 2,50±1,78 mm (Table 3) was found. Initially, the parameter of 6,89±2,98 mm reduced to 4,39±2,68 mm, which is statistically significant ($p<0,001$). The Twinblock device also caused parameter reduction. The intermaxillary distance was 6,35±2,76 mm and 3,33±2,23 mm before and after treatment, respectively. There was a decrease of 2.99±1.29 mm in this group which is statistically significant ($p<0.001$). We determined that using only at night, our modified apparatus aids in correction of mandibular-maxillary sagittal relationship. Wits parameter in this group was revealed to be 5,33±0,74 mm and 2,43±0,69 mm in pre and post treatment period respectively. It was determined that the parameter change is due to the forward displacement of the mandibular bone in whole as the backward replacement of A point was practically impossible. The mandibular bone forward replacement was 2,89±0,80 mm vs the maxllary bone while using the modified apparatus in children ($p<0,001$). Taking into account A point forward replacement relative to SNA angle is due to development processes, considerably forward replacement of the mandibular bone becomes obvious. Forward replacement of the mandibulaa affected more the lower incisors clinically. Simultaneously, variations in the lower incisors` torque degrees lead to increase in the amount of the incisors` edges forward replacement. Reduction in Wits parameter is clinically reflected in patients` profile. The lower lip base replaced forward consequently changing the shape of the labiomental fold and resulting in more aesthetic appearance. The Dynamax was used the whole day, the weaker change than the modified apparatus. The indicator of the correction was 2,36±0,76 mm comparing the pre- and post-treatment inidicators being 5,42±1,11 mm and 3,06±0,96 respectively.

Table 3.

Maxillary-mandibular relations values

Cephalometric parameters	Orthodontic appliances	Before treatment	After treatment	Difference	p
		M±σ	M±σ	M±σ	
Wits	Frankel	6,89±2,98	4,39±2,68	-2,50±1,78	***
	Twinblock	6,35±2,76	3,33±2,23	-2,99±1,29	***
	Mod. Twinblock	5,33±0,74	2,43±0,69	-2,89±0,80	***
	Dynamax	5,42±1,11	3,06±0,96	-2,36±0,76	***
	Twin-star	5,33±0,74	1,74±1,82	-2,85±2,19	***
	Maxillator	5,69±2,42	3,36±1,74	-2,34±1,67	***
	Control	3,36±2,19	3,62±2,63	0,27±2,49	
ANB	Frankel	6,18±1,89	3,40±1,39	-2,79±0,88	***
	Twinblock	6,45±2,13	4,99±2,30	-1,46±1,01	***
	Mod. Twinblock	7,25±2,00	4,39±1,85	-2,87±0,89	***
	Dynamax	5,43±1,59	3,19±1,82	-2,24±0,95	***
	Twin-star	7,25±2,00	3,50±2,13	-2,71±1,96	***
	Maxillator	7,82±2,15	5,01±1,70	-2,80±1,85	***
	Control	5,37±2,12	4,95±1,40	-0,42±1,39	
PL/ML	Frankel	23,50±6,47	24,70±5,45	1,20±2,43	
	Twinblock	24,88±4,78	23,77±4,74	-1,11±1,81	
	Mod. Twinblock	24,64±4,70	24,75±4,69	0,11±1,85	
	Dynamax	26,22±4,30	25,72±3,83	-0,50±3,39	
	Twin-star	24,64±4,70	23,42±5,03	-1,22±3,00	
	Maxillator	23,46±5,16	24,93±4,02	1,47±4,71	
	Control	25,18±3,18	23,99±3,25	-1,19±2,41	

* - p<0,05 ** - p<0,01 *** - p<0,001

With the effect of the Twinstar apparatus, the parameter decreased from 5,33±0,74 mm to 2,85±2,19 mm and reached 1,74±1,82 mm, the difference in the previous and subsequent values of the parameter being statistically significant (p<0,001). The amount of correction of sagittal discrepancy affected by the maxillator apparatus was 2,34±1,67 mm. The parameter initially was 5,69±2,42 mm, with a Maxillator effect becoming 3,36±1,74 mm. The Wits parameter change in terms of growth-development processes in untreated individuals was 0,27±2,49 mm, associated with processes in the periosteum. The necessary therapeutic effect was achieved by

changing the activator structure and reducing the duration of its use only the night time.

Forward displacement of mandible causes a decrease in the ANB angle. With the effect of the Frankel apparatus, the angle is reduced by 2,79±0,88 degree. The initial indicator of the angle was 6,18±1,89 degree, the subsequent indicator was 3,40±1,39 degree. The comparison of pre-and post-treatment values is statistically significant ($p<0,001$). In patients treated with Twinblock apparatus, the angle changed from 6,45±2,13 degree to 4,99±2,30 degree. The decrease in the angle was 1.46±1.01 degree. As a result of the impact of our modified apparatus, the angle has also been reduced. Though the short-term use of this device, the angle has decreased to 2.87±0.89 degree becoming normal ($p< 0.001$). In patients using the modified apparatus compared to the Frankel and Twinblock groups, the ANB angle was greater before treatment, which indicates the severity of distal bite anomaly. In Dynamax group, the angle reduced from 5,43±1,59 degree before treatment to 3,19±1,82 degree at the end of treatment, shrinking to 2,24±0,95 degree. With the effect of the Twinstar apparatus, the angle was reduced from 7,25±2,00 degree, to 3,50±2,13 degree. The change difference was 2,71±1,96 degree, which is statistically significant ($p<0,001$). In patients treated with maxillator apparatus, the angle was 7,82±2,15 degree at the first examination and 5,01±1,70 degree after treatment. The change difference for the treatment period was 2,80±1,85 degree. In our modified activator group ANB angle was defined to be 7,25±2,00 degree at the beginning of the treatment. The angle decrease became obvious in the course of the treatment. Analyses revealed that ANB angle value became 4,39±1,85 degree at the end of the treatment which was the normal indicator. SNA angle increase in 1 (one) degree has also been determined in the treatment period. It manifests that B point in anterior segment of the mandible has replaced more forward. Our modified activator had the greatest impact on the

correction of ANB angle with 2.87 degree among other orthodontic devices. In the untreated control group with distal bite, the ANB angle is found to be decreased to 0,42 degree. The shrinkage in this group is likely to be due to the remodelling of the bone on the vestibular side of the upper incisors root. These findings manifest the efficiency of the new treatment method in correction of the sagittal pathology. In our treatment group, comparison of ANB angle parameters for pre and post treatment period was statistically significant ($p<0,001$). This parameter difference is the main criteria of the skeletal pathology correction. ANB angle correction is clinically reflect on the sagittal relation of the nasal root and mandibular tip. In treated patients the forward appearance of nasal root was eliminated with the ANB angle decrease. Thus, the possibility of prognozing the decrease in ANB angle by changes in soft tissues became apparent. Skeletal changes may be defined by Glabella, the angle formed by connecting the subnasal and mandibular tip points, which reveals the changes in angle inclination.

Maintaining a vertical relation between the maxillar and mandibular bone while treating distal bite justifies the advantage of the orthodontic apparatus dento-alveolar control. While treating by the Frankel apparatus, the angle between the mandibular and maxillary bones is found to grow by 1,20±2,43 degree. Before treatment, the angle was 23,50±6,47 degree, then increased to 24,70±5,45 degree. Under the influence of the Twinblock apparatus, the angle between the jaws reduced. The angle of 24,88±4,78 degree before treatment decreased to 23,77±4,74 degree after treatment. The amount of shrinkage of the angle is 1,11±1,81 degree. Under the influence of the Twinblock apparatus, rotation of the mandible occurred in anterior upward direction. By impact of our modified apparatus the angle has remained relatively stable. In this group, the PL/ML angle, which was initially 24,64±4,70 degrees, becoming

24,75±4,69 degree after treatment. The angle has changed 0,11±1,85 degree, which means that the mandibular-maxillary planes maintain their inter-relation with the jaw bone replacing forward. The best indicator among the groups was in the group treated with the modified apparatus. In the Dynamax group, the parameter was 26,22±4,30 degree before treatment, under the apparatus effect it decreased to 25,72±3,83 degree. In the Twinstar group, the value of the angle has also decreased. The angle of 24,64±4,70 degree before treatment was reduced by 1,22±3,00 degree with the effect of the Twinstar apparatus and was determined to be be 23,42±5,03 degree in the post-treatment analysis. The maxillator apparatus` effect revealed to be close to the effect of the Frankel apparatus. In this group, the PL/ML angle increased by 1,47±4,71 degree, changing from 23,46±5,16 degree, to 24,93±4,02 degree. In patients using Maxillator and Frankel apparatus, bone thickness increase in the lower anterior segment of the mandibular body has been identified. In the control group, it was found that the angle is reduced by 1,19±2,41 degree due to the apposition of the periosteum in the angle of mandible. The change in the mandibular angle has occurred due to normal development.

Orthodontic devices used to change the position of the jawbone in the sagittal direction, transmit the force through the dento-alveolar region, causing teeth change. The Frankel apparatus influence resulted in a retrusion in upper incisors. The angle between the upper incisor and the NA line being initially 28,73±7,87 degrees, with the effect of the Frankel apparatus decreased 4,98±3,84 degrees. At the end of treatment, the angle became 23,75±7,45 degrees ($p<0,001$). The effect of the Twinblock apparatus and the Frankel device was similar. In this group, the angle was firstly 24,50±5,33 degrees, then 20,46±4,75 degree. During the treatment the angle decrease was 4,04±3,16 degree, which was statistically significant ($p<0,001$). As seen from the parameters before the treatment, the incisors subjected to the noticeable protrusion by the orthodontic apparatus we offered.

The angle has been normalized by providing the labial root torque to upper incisors in modified group. Prior to treatment, the angle was 31,35±3,27 degrees, shrinking by 7,25±4,97 degrees and reaching 24,09±4,71 degrees ($p<0,001$). The Dynamax apparatus has caused relatively little change in the inclination of the upper incisors. With the influence of the Dynamax apparatus, the angle from 27,24±8,78 degree decreased to 23,66±7,30 degree. The small difference is due to the fact that the device is partly non-removable. The least change in the inclination of the upper incisors was caused by the effect of the Twinstar apparatus. In these patients, the angle of inclination of the upper incisors decreased from 24,43±5,80 degrees to 23,44±5,34 degrees. The angle change in this group was 0,99±4,15 degrees. In the maxillator group the upper incisor/NA angle has reduced 1,65±4,05 degrees. Using this apparatus, the angle has changed relatively little from 25,35±5,56 degrees to 23,70±6,06 degrees since the lower tooth arch support is less. As a result of growth processes in untreated patients, 0,95±2,02 degrees protrusion was formed in the upper incisors.

All orthodontic devices used in the treatment of distal bite, contrary to normal growth, create a retrusion in the upper incisors. It is necessary to obtain the retrusion of the upper incisors through the root torque. This ensures the sagittal distance between the incisors not through the tooth displacements, but by forward displacement of the jawbone. Upper incisors/NA distance reduced by the effect of activators. The Frankel device causes the cutting edges of the upper incisors to shift back 1,76±1,71 mm. The parameter reduced from 5,80±3,34 mm, to 4,05±2,86 mm, the difference being statistically significant ($p<0,001$). Under the influence of the Twinblock apparatus, the amount of backward displacement of the upper incisors is the same as in the Frankel apparatus. In this group, the distance was 5,60±1,44 mm before treatment and 3,88±1,46 mm at the end of treatment. The cutting edges have backward displacement in 1,72±1,06 mm ($p<0,001$). During the treatment with the apparatus we offer, the retraction of the upper incisors was 2,00±1,73 mm ($p<0,001$). Activation of the vestibular arch of the upper apparatus has yielded its results. Among the methods of treatment, the most

changes in parameter amount were stated by using the Dynamax apparatus. Initially being 6,97±3,17 mm, the upper incisors/NA distance decreased 2,10±1,72 mm under the impact of this device and became 4,87±2,15 mm. The comparison of the previous and subsequent values of the parameter is statistically significant ($p<0,001$). Since the Twinstar apparatus covers the upper incisors with the bioacril material, there was no retrusion in these teeth. The parameter was initially 4,23±1,53 mm, then 4,40±1,50 mm. In the upper incisors there was a protrusion of 0,16±1,66 mm. The retraction caused by the maxillator apparatus is less than with other apparatus. Thus, the parameter of 5,17±2,40 mm reduced to 4,21±1,56 mm with 0,96±2,17 mm of retraction. As a result of normal development, it has become known that in the incisors of children with distal bite 0,56±0,74 mm protrusion takes place. The protrusion is more in children, with lower lip between the upper and lower incisors. It may be stated that it is possible to control the sagittal position of the upper incisors crowns with activators.

The upper cutting A-FH perpendicular parameter was reduced by the effect of activators. This shrinkage in the Frankel group was 0,47±1,55 mm. The parameter was reduced from 6,36±2,40 mm to 5,89±1,55 mm. Applying the Twinblock apparatus has led to a further decline. Thus, when the parameter was 4,92±1,38 mm at the beginning, by the Twinblock effect, it decreased by 1,15±0,77 mm and the eventually becoming 3,77±1,16 mm ($p<0,001$). Under the influence of our modified apparatus, the upper incisors retruded 0.85±1.44 mm relative to the perpendicular line to point A. The distance decreased from 4,32±2,47 mm to 3,47±3,02 mm ($p<0,05$). The Dynamax apparatus induced a greater retrusion compared to our apparatus. The upper incisors initially being at a distance of 5,96±4,11 mm to the reference line, then moved back 1,64±2,91 mm and reached 4,32±3,78 mm. This displacement is statistically significant ($p<0.05$). The Twinstar apparatus caused 0,80±2,44 mm retrusion on the upper incisors. Thus, the parameter was reduced from 4,56±2,78 mm, to 3,76±1,94 mm. The maxillator has also changed the parameter as much as the Twinstar apparatus. Under the influence of this apparatus, the backward displacement amount was

0,86±1,69 mm, which is not statistically significant. In this group, the upper incisors protrusion was 7,01±2,30 mm and 6,15±2,59 mm in pre and post treatment period respectively. In the control group, this parameter is found to increase 0,65±1,03 mm. The change is due to the pressure on the teeth caused by the lower lip located in the sagittal cleft between incisors. The Dynamax treatment was most effective in backward displacement of the equatorial parts of the upper incisors crowns.

It has been known that there is a bending back of upper incisors' inclination with regard to the palatal plane. Under the influence of the Frankel apparatus, the incisors` inclination decrease was noted to be 5,44±4,06 degree. The angle has reached to 111,72±7,43 degree from 117,16±7,47 degree. With the influence of the Twinblock apparatus, the more shrinkage was noted. In this group, the angle was initially 119,14±5,58 degree, then it has become 108,48±6,43 degree, with the shrinkage of 10,66±5,83 degree ($p<0,001$). The change with our modified apparatus was relatively small, being only 6.54±5.42 degree. The change by the Dynamax apparatus was less than the change caused by our apparatus. In this group the parameter was previously 130,29±6.24 degree, then it reduced 6.08±6.09 degree by treatment, finally becoming 124.21±9.85 degree ($p<0.01$). The upper part of the Twinstar apparatus creates more stability in incisor, resulting in a parameter change of 1,13±4,23 degree. The treated with the maxillator group, the angle reduced from 113,82±6,75 degree, to 113,71±6,80 degree. The change in this group was the least with 0,11±3,66 degree. With growth, a slight protrusion is formed in the upper incisors leading to 0,67±2,72 degree angle increase.

Orthodontic treatment of the distal bite has resulted in the position change of the upper teeth with regard to the skull base. With the effect of the Frankel apparatus, the upper incisors/SN angle has grown 9,91±2,67 degree, from 79,30±5,91 degree, to 89,21±6,56 degree. The difference resulting from the treatment is statistically significant ($p<0,001$). The Twinblock device treatment also caused the growth of the angle. In this group, the angle before treatment was 70,32±5,82 degree, becoming 81,39±7,53 degree with an increase of

11,07±6,20 degree after wards (p<0,001). As a result of the our moidified apparatus treatment, the angle decreased 5,28±3,07 degree approaching the normal value. The parameter of 113,98±10,03 degree before treatment, then became 108,70±9,60 degree. The reduction of the angle is statistically significant (p<0,001). The Dynamax apparatus influence has also led to the forward displacement of the upper incisors root endings like the Frankel and Twinblock apparatus. As a result, the upper incisors/SN angle has grown 5,45±4,05 degree, increasing from 77,30±9,38 degree to 82,75±6,61 degree (p<0,001). Comparing with the previous parameters, the Twinstar apparatus changes were very little, from 106,05±6,55 degree decreasing to 105,21±6,54 degree. During this period, 0,84±3,94 degree retrusion has occured. The maxillator apparatus also made very little changes in this parameter. The angle firstly increased 0,18±1,59 degree from 103,39±6,02 degree to 103,57±6,56 degree. In the control group there was an increase of the angle in 1,00±3,00 degree, which occurred as a result of bending back of the upper incisors roots. Analyzing the results, the most effective way for upper incisors to acquire the buccal root torque was to apply our modified apparatus and Twinstar. By applying other devices the palatal root torque formed of the upper incisors.

In the course of the distal bite treatment, the lower incisors displacement affects the distance between the incisors and the sagittal control of these teeth increases the bone effect. Under the influence of the Frankel apparatus, a protrusion of 3,44±3,52 degree was formed on the lower incisors. The lower incisors-NB line angle was 27,17±4,21 degree before treatment with the Frankel activator, further becoming 30,60±3,68 degree. The amount of protrusion formed in the lower incisors is statistically significant (p<0,001). The Twinblock apparatus also created a protrusion in the lower incisors. The lower incisors' inclination from 20,55±5,68 degree descends to 22,19±6,81 degree. There was a protrusion of 1,65±9,80 degree. The amount of protrusion formed in the lower incisors with our modified apparatus was 4.95±3.41 degree (p<0.001) more than in other groups. It may be considered as a disadvantage of our own apparatus. An increase in the lower incisor's inclination indicates that the

therapeutic effect partly occurs due to dento-alveolar changes. The lower incisors' inclination in the Dynamax apparatus group ranged from 25,29±7,79 degree to 34,07±7,23 degree with the difference of 8,78±5,05 degree, which is the highest value among the groups ($p<0,001$). The Twinstar apparatus has supported the lower incisors to be relatively stable, as in the case with the upper incisors. In this group, the angle from 26,06±5,09 degree ascended to 28,13±6,07 degree. During the treatment period, incisors were inclined forward 2,08±3,84 degree ($p<0,05$). The change caused by the effect of the maxillator apparatus was 2.15±5.28 degree, near to the Twinstar apparatus. The inclination from 28,30±7,97 degree reached to 30,45±6,83 degree. It was revealed even with normal growth, under the pressure of the tongue, the lower incisors may be subjected to protrusion in 1,92±2,55 degree. From this point of view, the 4.95 degree protrusion generated by our apparatus may be an acceptable indicator. When we evaluated the sagittal position, but not the inclination of the lower incisor's crown, the forward displacement was noted. During Frankel treatment, the crowns of the lower incisors moved 1,93±1,16 mm forward. Lower incisors/ NB distance was previously 4,53±1,61 mm, then became 6,46±1,52 mm ($p<0,001$).

The twinblock apparatus has made the crowns of the lower incisors to be displaced a little forward. In this group, the parameter was 4,09±1,35 mm, afterwards 5,39±1,02 mm, and the forward displacement was 1,30±1,15 mm ($p<0,001$). In the modified apparatus group, the incisor's crown forward displacement was 1,46±1,39 mm. Though our apparatus effect on the lower incisor/NB angle is likely to be weak, the lower incisor/NB distance indicator has been near to other apparatus. It indicates that torque changing by modified apparatus resulted of root displacement. Since the amount of the lower incisors crowns forward displacement is minimal, it does not weaken the skeletal effect of the appliances. In the group treated with the Dynamax apparatus, the parameter was ranging between 4,50±2,95 mm and 7,66±3,01 mm before and after treatment ($p<0,001$). During the treatment course, 3,17±1,15 mm of protrusion was observed due to poor incisor control of the appliance. The

Twinstar apparatus has a better outcome compared to the Frankel, twinblock and our apparatus. In this group, the lower incisors displacement was from 3,94±1,62 mm to 4,80±1,65 mm, with a protrusion of 0,86±1,19 mm, which is the minimum value among these groups. The maxillator apparatus also has a high performance. In this group, the lower incisors/NB distance was 4,86±1,84 mm before treatment and 5,74±1,59 mm after with the difference of 0,88±1,39 mm ($p<0,05$). The protrusion of the lower incisors' crowns in untreated patients was 0.56±1.02 mm. It is caused by imbalance of force between the tongue and lip muscles. According to the outcomes of the investigation, it may be concluded that our apparatus is effective to other appliances, except the maxillator and twinstar apparatus.

The distance from the crown of the lower incisors to the A-Pg line has also proved the presence of the protrusion in these teeth. The lower incisors/A-Pg distance of 0,84±1,43 mm increased by 1,79±2,84 mm with the treatment of the Frankel apparatus reaching 2,63±2,68 mm ($p<0,63$). The Twinblock device also increased the value of the parameter from 2,16±2,53 mm to 3,73±1,86 mm. The parameter increased by 1.57±1.68 mm, which is statistically significant ($p<0.05$). According to the lower incisor/A-Pg parameter, 0.97±1.53 mm forward displacement has occurred in the lower incisors under the influence of our apparatus which is less than in the Frankel and Twinblock apparatus groups. Better control on lower incisors crowns by the modified apparatus is identified. It becomes obvious that the gap in the lower incisor/NB angle is due to the displacement of the NB line and the protrusion of the lower teeth is minimal. As a result of poor control of the Dynamax apparatus on the lower incisors, the parameter changed from -1,05±4,70 mm to 2,41±4,87 mm, the difference being 3,45±2,54 mm ($p<0,001$). A similar amount of protrusion occured in the Twinstar group. Initially being 0.08±2.26 mm, in the duration of the treatment course it increased to 3.52±1.71 mm eventually becoming 3.60±1.99 mm ($p<0.001$). The change caused by the effect of the maxillator is 1.34±1.23 mm, being second after the change caused by our modified apparatus. The parameter of the lower incisors/A-Pg with a

Maxillator effect ascended from 1,87±2,34 mm to 3,21±2,08 mm ($p<0,001$). The change in the control group was 0.59±0.87 mm, slightly smaller than modified apparatus group. It becomes obvious that our apparatus can better control on the lower incisors compared to other apparatus.

The sagittal distance between incisors is one of the main criteria of occlusion that should be considered in distal bite anomalies. Due to a large size of this distance in patients with distal bite, the occlusion contact between the upper and lower incisors is disturbed. In many cases, the cleft between the upper and lower incisors is occupied by a lower lip. With orthodontic treatment, the sagittal distance between the incisors is reduced. In patients treated with a modified new apparatus, this parameter was reduced by 4,43±1,41 mm. It decreased by 7,68±1,54 mm and 3,26±0,84 mm (very close to the norm of 3 mm) pre and post- treatment period, respectively. In patients treated with Frankel, this distance was reduced by 5,92±1,22 mm. In this group, the parameter before treatment was 10,11±1,75 mm, after treatment became 4,19±1,23 mm. With the effect of the Twinblock device the parameter was reduced from 8,36±1,63 mm to 3,78±0,75 mm. In this group, the change was 4,58±1,59 mm which is statistically significant. At the end of Twinblock treatment, the sagittal distance between the incisors became close to the norm. In the group we treated with the Dynamax apparatus, the distance between the incisors initially being 9.75±2.14 mm, decreased by 5.12±1.87 mm and became 4.63±1.18 mm. The Twinstar apparatus has also created a change close to our apparatus. Under the influence of this apparatus, the parameter reduced by 4,39±3,24 mm. Before treatment it was 8,02±2,98 mm, subsequently becoming 3,64±1,62 mm ($p<0,001$). In other treatment group, this parameter was 8,19±2,25 mm, with maxillator treatment it decreased by 4,32±1,78 mm and reached to 3,88±1,81 mm finally. In the control group, this parameter reduced by 0,25±1,33 mm. In relation with growth, a protrusion occurs in the lower incisors, resulting in the reduction of sagittal distance between incisors. Simultaneously, with the sagittal distance decrease between the incisors, the angle growth between incisors and the proper contact of

the lower incisors edges with the upper incisors palatinal prominence is restored.

When the sagittal position of the mandibula and the tubercul-fissure relationship between the upper and lower teeth changes, resulting in a vertical slit between the upper and lower incisors. In patients treated with the modified new apparatus, the vertical distance between the incisors decreased by 1.26±0.93 mm. This is achieved by increasing the height of the acrylic part of the orthodontic apparatus in occlusion, preventing the extrusion of molars. With the impact of the Frankel apparatus we determined that the vertical distance between the incisors decreased by 3.06±1.98 mm. The distance being initially 4.80±2.12 mm, has become 1.75±1.45 mm after the use of the Frankel ($p<0,001$). With the effect of the Twinblock apparatus, the parameter reached from 4.46±1.98 mm, to 2.31±1.41 mm. There was a difference in 2.15±1.72 mm comparing pre and post- treatment indicators, which is statistically significant. With the effect of the Dynamax apparatus, this parameter changed to 2.49±1.64 mm. During our treatment with Twinstar activator, the vertical distance between the incisors was relatively larger 3.01±1.66 mm. In these patients group, the parameter was 4.41±2.13 mm before treatment, further becoming 1.41±1.55 mm. In distal bite patients treated with a Maxillator activator, the parameter decreased by 2.37±1.44 mm, changing from 3.84±1.19 mm to 1.47±1.27 mm ($p<0.001$). In the control group, decrease in this this parameter is also observed.

Under the influence of distal bite activators, the inclination of the occlusion plane changes. The Frankel activator caused an 1.08±3.85 degree inclination increase. The angle between the occlusion line and the SN plane increased from 17.62±5.56 degree to 18.70±4.17 degree. Under the influence of the Twinblock apparatus, the inclination of the occlusion plane has changed more. The angular difference was 2.99±1.99 degree ranging from 15.05±3.41 degrees before treatment to 18.04±4.39 degrees after ($p<0,001$). In patients treated with our apparatus, this parameter changed less than in the Twinblock group, only 1,63±2,19 degrees, as we controlled the vertical development of posterior teeth. With the influence of the

Dynamax apparatus, the angle change ranges from 18,44±4,23 to 20,81±5,61 degrees. In patients using the Twinstar apparatus, the angle difference is 1,44±2,84 degree varying from 16,79±4,16 degrees to 18,23±3,98 degrees before and after treatment respectively. The maxillator activator, unlike the others, caused the anterior-upward rotation of the occlusion plane. As a result, the angle was reduced 0,67±3,45 degree ranging from 20,73±3,84 degrees to 20,06±3,34 degrees. The control group also has anterior-upward rotation of the occlusion plane with the extrusion of incisors. Thus, the change indicators in inclination of the occlusion plane caused by various treatment methods were close among the groups. In some cases, aesthetic discrepancies in occlusion after activator treatment are corrected with non-removable orthodontic appliances.

The rotation formed in the mandibula affects the vertical position of the mandibular tip. Consequently, the facial height changes. The N-ANS distance showing the midface height has grown 0.76±1.57 mm in patients by using Frankel apparatus. The parameter range was 56,68±3,00 mm and 57,44±2,78 mm in pre/post period treatment respectively. In patients using the Twinblock apparatus, the height has increased relatively more 1,39±1,35 mm from 55,33±4,16 mm before treatment to 55,75±3,84 mm after it. The modified apparatus is more effective in the growth of facial height as there has been an increase of midface by 3,18±0,96 mm in patients using this apparatus. Under the influence of the Dynamax apparatus, N-ANS has increased from 67,18±6,00 mm to 70,56±6,41 mm. In the group treated with the Twinstar apparatus, the parameter increase was 2,02±1,80 mm. The average height of the face using maxillator apparatus changed from 59.23±4.95 mm to 61.44±4.71 mm. It was apparent that the face height in the control group increased by 2,18±2,57 mm. It was determined that the activator offered by us and the Dynamax apparatus caused additional to normal growth changes. Other activators do not have the same effect like this. Since orthodontic treatment is carried out in the dento-alveolar region, a change also occurs in the height of the lower 1/3 of the face. It should be prevented because the growth of the lower face height violates the ratio of 1/3 parts of the face. Treatment with the new

apparatus resulted in the least change of ANS-Me distance, being 2,41±2,50 mm ($p<0.01$). A slight change in the parameter was obtained due to the control of posterior teeth with the help of acrylic occlusial planes of the upper apparatus. In patients treated with the Frankel apparatus there was a 3.84±2.34 mm change in the ANS-Me distance. The lower face height was 66,27±5,06 mm before treatment, afterwards becoming 70,11±3,88 mm ($p<0,001$). In patients treated with Twinblock activator, this parameter changed 3,05±1,41 mm from 64,41±6,28 mm to 67,46±7,21 mm. In Dynamax treatment group, the growth of the lower 1/3 face height was close to the same indicator in new apparatus group (2,83±3,48 mm). In the group treated with Twinstar, the parameter increased by 4,57±3,11 mm. The height of the lower 1/3 face has increased more in this group. During the treatment of the maxillator apparatus, as in the case of a modified new apparatus, the ANS-Me height increased by 2.65±1.02 mm as a result of the controlling the posterior teeth. The effect on the face height caused by non-removable orthodontic bands placed on molar teeth in the lower dental arch was apparent in this group, too. With normal growth, the height of the lower part of the face increased by 3,34±2,31 mm. Overall face height (N-Me) increased 5,09±1,87 mm with Frankel apparatus. In Twinblock treatment group, the face height change of 4,5±1,66 mm was less comparing to the group with Frankel apparatus treatment. A change in this parameter as a result of a modified apparatus treatment was 5,27±1,20 mm ($p<0,001$). Dynamax and Twinstar apparatus effect also created the similar changes. In the control group, we also determined that as a result of the growth, the facial height increased by 5,12±4,16 mm ($p<0,001$). Thus, during the treatment of distal bite, applying the Twinstar and Frankel apparatus resulted in increased height of the lower 1/3 face, whereas the other activators affected the mandible to move forward protecting the facial height.

During the treatment of distal bite, changes in skeletal and dento-alveolar tissues affect the soft tissues, as well. It must be stated that different methods of treatment cause various changes in soft tissues of the face. In patients treated with Frankel, the backward displacement of the upper lip with the difference of 2,07±1,37 mm

was observed. The distance from the upper lip to the soft tissue line was 1,46±2,12 mm before treatment, then -0,61±2,11 mm ($p<0,001$). Under the influence of the modified new apparatus, the upper lip is shifted 1.45±1.80 mm back ($p<0.01$). In patients with distal bite, treated with the Dynamax apparatus, the upper lip moved 2,51±1,10 mm back. In this group the distance from the upper lip to the soft tissue line was 1,86±2,37 mm before treatment, then 0,65±2,18 mm. The Twinstar apparatus has an effect close to the Frankel and Dynamax apparatus on the upper lip. In children using this apparatus, the upper lip-E line had reduced 2,37±1,93 mm. During the treatment with the maxillator apparatus, the lip moved back 1.12±1.81 mm. The parameter initially was -0,85±2,63 mm, then was -1,97±2,68 mm. In the control group, 0,45±1,43 mm backward displacement of the upper lip associated with a change in the position of the upper lip was noted. We may come to conclusion that the new modified apparatus has maximum effect on the upper lip comparing with Twinblock and maxillator apparatus.

A change in the inter relations of upper and lower incisors has also affected the sagittal position of the lower lip. During the Frankel activator treatment, the backward displacement of 0,59±1,56 mm in the lower lip was observed. Lower lip E- line was 1,68±2,59 mm and 1,09±2,27 mm in pre and post treatment period, respectively. In Twinblok treatment, the change was less, being 0,14±2,19 mm. The parameters in this group were initially 0,89±2,52, after wards 0,75±1,47 mm. Lower lip backward replacement relative to soft tissue line was obvious in group treated by our modified apparatus (Picture 7.). This change was linked with the forward replacement of the mandibular tip region. The displacement indicator amount in the lower lip caused by the modified orthodontic apparatus was 1,09±2,25 mm. The findings manifest the more appropriate position obtained by the lower lip due to forward replacement of the mandibular tip. Such a change in the lower lip is essential to provide the profile appearance aesthetic optimum. The proper position of the lower lip was provided by the increase in the facial height. Distal bite orthodontic treatment without increasing the facial height may be achieved by a more forward replacement of the lower lip.

Considering this fact, our new modified apparatus provided the forward and downward replacement of the mandibula, thus paying contribution to distal bite treatment. Minor protrusion in the lower incisors while using this device does not affect the lower lip forward displacement. In Dynamax group this parameter changed from 0,12±3,55 mm to -0,13±2,82 mm and backward replacement of 0,25±2,06 mm has occurred. In Twinstar group pre and post treatment parameters were 0,32±1,49 mm and 0,57±2,56 mm respectively, with 0,25±1,73 forward replacement. Protrusion caused by Maxillator activator in the lower lip was 0,27±2,30 mm. Lower lip distance to referance line initially being 0,20±3,25 mm, further changed to 0,07±3,02 mm. Retrusion of the lower lip in the control group was apparent to be 0,51±1,89 mm. The difference in parameter change in the treatment and control groups indicates that in patients with distal bite lower lip position depends not only on the method of treatment, but on individual characteristics, too. In some cases of the distal bite anomaly, the upper and lower lips remain distant. This distance being 2,22±1,80 mm in patients at the beginning of the treatment has changed to 0,71±0,76 mm after Frankel activator treatment.

a b

Picture 7. Lower lip moved back with modified activator: a-before, b-after treatment

The lips became closer in 1,51±2,09 mm (p<.0,01). In Dynamax group this distance decreased by 1,31±1,72 mm changing from 1,73±1,91 mm to 0,41+042 mm (p<0,01) and clinically, lip closure was noted. Twinstar treatment didn't achieve in complete lip closure. In patients treated by Twinstar the distance between lips initially being 3,90±2,14 mm then has become 2,61±2,74 mm (p<0,05). Maxillator activator, like Twinstar couldn't achieve in complete lip closure. In patients treated by Maxillator, interlabial distance of 3,86±2,21 mm decreasing by 0,82±2,36 mm reached to 3,04±2,07 mm eventually at the end of the treatment. In untreated patients the interlabial distance has grown by 0,73±1,63 mm. Under the influence of the modified activator, Frankel, Twinblock and Dynamax activators, normal closure of the lips is ensured. Twinstar and Maxillator devices did not have the necessary effect.

If the nasolabial angle ranging between 94-110 degree is considered to be normal, our new modified apparatus treatment effect prevails Frankel and Twinblock devices with the less violation from norm. The Dynamax apparatus was marked to have better effect. The angle with decrease of 1,28±8,73 degree approached to norm changing from 117,49±10,27 to 116,21±13,43 degree. In Maxillator group patients the alignment existing before treatment was preserved during orthodontic treatment. The angle parameter decreasing 3,38±1,62 degree changed from 106,55±5,20 degree to 103,17±5,24 degree (p<0,001). In terms of the nasolabial angle, the more effective results may be achieved with the application of the Dynamax, Twinstar and Maxillator than other treatment methods.

Upper lip inclination relative to perpendicular from Nason point to Frankfort horizontal line different according to distal bite treatment methods. Frankel apparatus caused 1,50±3,88 degree protrusion due to the dislocation of the upper lip vermilion. Upper lip N- FH perpendicular angle initially being 12,15±4,30 degree, then changed to 13,66±4,77 degree. Upper lip retrusion is desirable result for convex profile correction in distal bite treatment. Among the treatment methods Frankel and Twinstar appatus treatment didn't achieve the desirable effect in upper lip retrusion. The favourable treatment results were obtained by other methods. It became apparent

that the depth of the nasolabial fold decreases by the growth of the dental arch transversal dimension, thus restoring the aesthetic appearance.

Due to disturbance in sagittal relation of the occlusion plane, a part of the lower lip red frame folds down, consequently leading to deepening of the lower labiomental fold. In modified activator treatment group this fold is straightened, being before treatment 121,44±7,66 degree and after treatment 135,47±9,64 degree ($p<0,05$). Labiomental angle correction is of great importance for the profile appearance ensuring the aesthetic optimum of the oral structure. In Frankel treatment group, the labiomental angle was marked to change from 115,14±17,91 degree to 136,59±16,65 degree with angle increase of 21,45±10,92 degree. Such kind of change clinically provides the profile correction. Labiomental angle growth by Twinblock is close to the modified apparatus effect, being 15,63±12,72 degree. The labiomental angle parameter initially was 127,27±14,13 further changed to 142,90±13,11 degree ($p<0,001$). In Dynamax group, though the angle previously was beyond due norm (103,30±15,76 degree) during the treatment period, increasing by 8,13±12,27 degree, eventually reached to 111,43±16,41 degree. In Twinstar and Maxillator groups, the angle being too small before treatment, wasn't fully normalized during treatment. In Twinstar group labiomental angle of 84,34±11,89 degree initially, changed to 96,59±13,60 degree with difference of 12,26±14,53 degree ($p<0,01$). In Maxillator group patients, the angle of 87,99±9,91 degree before treatment, increasing by 11,66±11,58 through treatment has become 99,65±16,19 degree ($p<0,01$). The labiomental angle is marked to be reduced to 6,23±13,87 degree in control group. The considerable correction in labiomental angle is caused by Frankel apparatus which is then followed by Twinblock and the modified apparatus indicators.

The upper and lower lips are in contact in the normal occlusion during the relative physiological relaxation. In most distal bite cases, violation in physiological state of the lips is apparent. The appearance of open lips is similar both in girls and boys. In children with vertical opening between lips approximately more than half of the upper incisors are appears. The relative physiological relaxation

conditions with violation in the contact between the lips are more frequent in children with oral respiration due to nasal breathing problems. Usually because of oral respiration at nights, they get accustomed to open lips. Even though the nasal respiration function is restored, the condition of open lips lasts despite the adaptation of the lips. Violation in contact shape of the incisors characteristic to distal bite disturbs the lips appearance. The upper incisors positioned between the upper and lower lips prevent the lip contact. The lower lip occupies the sagittal space formed between the upper and lower incisors. We have come to conclusion that the placement of the lower lip between the upper and lower incisors results in enlargement of the sagittal distance. As a result of the lower lip pressure on the upper incisors palatal surface, their crowns bend forward and the lower incisors contact with the lip surface causes them to bend backward. Consequently, the sagittal distance between the upper and lower incisors' crowns is enlarged. Due to folding of the lower lip, the soft tissue thickening may also be noticed. Therefore the upper lip cannot reach the contact point with the lower lip. The misalignment in the interlabial contact appears as a facial aesthetic deficiency. With the application of the modified activator, Frankel, Twinblock and Dynamax normal lip closure is ensured. Twinstar and Maxillator were not sufficiently effective. Backward position of the mandible causes changes in the angle between the lower nasal surface and upper lip (nasolabial angle). When the distal bite is treated, the mandibular displacement affects the nasolabial angle. According to our research result, the nasolabial angle is normalized with the effect of the modified apparatus. The Dynamax, Twinstar and Maxillator activators are also highly effective in the treatment of the distal bite anomalies.

Analyses of various orthodontic appliances used in the distal bite treatment made it possible to determine their side effects. The study determined that the similar effect as the orthodontic devices applied the whole day and sometimes even over results were achieved by the new modified apparatus used only night time.

CONCLUSIONS

1. During the clinical examination of 168 patients with different types of distal bite, 17% speech disorders, 13% traumatic occlusion of the incisors, 11% periodontal tissues pathologies were identified. In 64% of patients oral respiration, in 76% discrepancy between the transverse dimensions of the dental arch, in 67% dental arch deformations, in 4% short lip frenulum were determined; skeletal and soft tissue changes were detected before and after treatment as a result of radiographic, photometric, cephalometric and model analyses [53, 62].

2. Cephalometric analysis of patients with distal bite showed that the maxillary bone in the craniofacial complex is of normal size and position in the sagittal direction. Thus, the SNA angle was 80,45±3,63 degrees in girls, 80,84±3,08 degrees in boys, the distance from the N to FH perpendicular line to point A was 0,87±3,26 mm in girls, 0,14±3,53 mm in boys, ANS-PNS length was 57,46±5,33 mm in girls, 57,69±4.86 mm in boys. Small size of mandible and its retracted position is reflected by Co-Gn distance 104,30±8,13 mm in girls, 105,76±9,34 mm in boys, SNB angle 74,09±3,41 degrees in girls, 74,64±3,19 degrees in boys, N-FH perpendicular line to Pg point distance -7,74±6,20 mm in girls, -9,00±4,71 mm in boys. In the distal bite case, upper incisors are in protrusion position and lower incisors are in normal inclination. The interlabial distance during relative calmness is 3,66±3,09 mm in girls, 2,32±2,36 mm in boys. Thus, clinically, the growth of the nasolabial angle can be used as an early diagnostic criterion for distal bite [53, 60, 62].

3. It must be concluded that to achieve a result within 1.5-2 years is possible starting the distal bite treatment with activators in the pre-puberty period and taking into account the forced occlusion, vertical height, the chewing muscles tonus and regulating the volume of the sagittal activation. In assessing the effectiveness of the distal bite treatment, the Wits parameter provides more accurate information than the ANB angle. Because the Wits parameter evaluates sagittal relations of maxillary and mandibular bones without taking into account the changes in the S-N plane and the

nazion area. All activators applied during distal bite treatment caused the forward displacement of the mandibular bone [17, 22, 41, 42].

4. According to the results of cephalometric analyses, cranial base growth was mostly observed in the patients using our modified activator (2,34±1,10 mm) and the maxillator (2,28±1,67 mm) in the treatment of distal bite with various activators. Sagittal growth of maxillary bone was minimal in those who used Frankel-2 (0,69±1,67 mm) and Twinblock activator (0,93±1,94 mm). The sagittal size of the mandible is determined to grow 3-5 mm in the treatment groups appropriate to control group. The most remarkable forward displacement of the mandibular bone was caused by our modified activator (3,69±1,01 degrees) and the maxillator activator (3,25±1,72 degrees). Correction of the sagittal relations of maxillary and mandibular bones was more commonly revealed in distal bite patients treated by Twinblock (2,99±1,29 mm) and the modified activator (2,89±0,80 mm) [33, 50, 51, 54, 58, 61, 63].

5. It is determined that the most retraction of the upper incisors occurred in the Dynamax (2,10±1,72 mm) and modified activator (2,00±1,73 mm) groups as a result of the activators` effect on occlusion in the course of distal bite treatment. Frequency of the correction of overjet in patients using the Frankel-2 (5,92±1,22 mm) and Dynamax (5,12±1,87 mm) devices. However, the use of these devices is likely to result in undesirable protrusion of the lower incisors. To prevent such cases, applying the Twinstar (0,86±1,19 mm) apparatus is appropriate [48, 49, 51, 58, 59, 61].

6. The study revealed that the use of the Dynamax activator in distal bite patients with a greater extent upper incisors protrusion and the use of our modified activator in patients with a weak developed mandibular bone and open bite may have better results. The use of the Twinblock activator is more effective in patients with maxillary bone overdeveloped forward (SNA decreased 0,29±1,02 degrees). Applying the Twinstar (Go-Me increased 4,09±3,94 mm) and modified activator is more effective in patients with short mandibular body (Go-Me increased 3,63±1,48 mm) [47, 48, 49, 55, 58, 63].

7. In the modified activators treatment group of patients with distal bite providing the facial esthetic optimum through the most prominent forward displacement of the mandible (SNB, 3,69±1,01 degrees), the least change in the lower 1/3 of the face height (2,41±2,50 mm), almost stable vertical orientation of the palatal-mandibular body plane (0,11±1,85 degrees change), the 2,87±0,89 degree normalization of ANB angle of the maxillar-mandibular sagittal relations and 4,43±1,41 mm normalization of overjet, correction in naso-labial, labio-mental sulcusus and inter-labial distance prove that sustainable results and the optimal treatment of distal bite anomaly may be achieved introducing the proposed orthodontic treatment method [51, 55, 56, 57, 58, 62].

PRACTICAL RECOMMENDATIONS

1. It is necessary to apply differential diagnostics and modern treatment methods and techniques in distal bite anomalies in children for reducing the period of orthodontic treatment and improving its efficiency to restore the chewing and speech functions and eliminate aesthetic defects of the face. Clinical tests, X-ray, photometric, cephalometric, model analyses and comparative assessment of their findings must be carried out for differential diagnosis.

2. Special attention should be paid to early diagnostics and specialized treatment of nasal breathing problem since the occurrence of oral breathing in children and narrowing of the upper dental arch in the transverse direction are the main factors causing the distal bite. The genetic nature of the anomaly, its origin, degree of severity, inclination degree of the incisors, overjet, the patient`s growth and development stage, the nature of soft tissues, the transverse discrepancy of the dental arch should be taken into account while choosing the distal bite treatment method. The pre-puberty stage is more favorable for starting the treatment to shorten the duration of treatment.

3. During the distal bite of skeletal origin, it is necessary to prevent forward development of maxilla since its backward displacement is practically impossible. Taking into account the

occlusion factors, the mandible should be positioned forward. Expansion of the upper dental arch is essential in many cases because upper dental arch narrower than the lower in the transverse direction and the violation of the tubercul-fissur relations prevent the mandible to grow forward.

4. Acrylic inclined plane of the modified orthodontic apparatus, arranged in the superior-posterior directions ensure the required stable position of mandible; not using the apparatus in the daytime causes comfort with chewing and speech functions. The modified apparatus` advantage is creating forced occlusion to provide necessary therapeutic effect through night time use only. To prevent protrusion of lower incisors, acrylics should be added to the vestibular arch at the bottom of the apparatus.

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