Diagnostic and Therapeutic Preventive Features of Sagittal Dentofacial Anomalies in Children

Sur'at Gulyamov[1], Dilshod Karimov[2]

[1]MD, Doctor of medical sciences, Professor, Department of Otorhinolaryngology, Pediatric Otorhinolaryngology, Stomatology, Tashkent Pediatric Medical Institute, 223 Bogishamol Str., Yunusobod District, Tashkent, Uzbekistan,
[2]PhD, MD, Teaching Assistant, Department of Otorhinolaryngology, Pediatric Otorhinolaryngology, Stomatology, Tashkent Pediatric Medical Institute, 223 Bogishamol Str., Yunusobod District, Tashkent, Uzbekistan

Abstract

This article presents the specific features of clinical and radiological abnormalities in the mixed dentition. Individuality of such features is determined by the parameters of the maxillofacial region and the maxillary dimensions, in the form of late milk dentition abrasion, shape of the submaxillary retromolar area and the eruption level of the lower first and second multi-cuspid teeth according to the dental panoramic radiogram. All above was used as a basis for the assessment algorithm development for children with the dentofacial anomalies. Based on the results obtained, the recommendations has been proposed that allow to perform individual treatment for the children with this pathology.

Keywords: *Dentofacial anomalies, orthodontics, sagittal anomalies, anterior occlusion, distal occlusion.*

Introduction

According to WHO data, the prevalence of dentofacial anomalies is on average at least 50% (WHO, Geneva, 2016)[1]. According to the National Institute of Dentistry, USA, 40% of the total population have abnormalities in the teeth development and various dental formation disruptions[2]. Moreover, 15% of these individuals require surgical intervention for its elimination. The issues of timely elimination and removal of factors that adversely affect the normal formation of the dentofacial complex are rather relevant[10].

According to the world scientists, the occlusion anomalies affect the general and local diseases[5] of the human body and cause malfunctions of chewing, breathing, speech and swallowing[8]. The early diagnostics problem of latent forms of the sagittal dentofacial anomalies and its timely prevention and treatment is of undoubted practical interest[3]. It is due to the profound morphofunctional lesions that affect the proper development of chewing function, maxillary formation and occlusion[9].

This impairment is characterized by an unaesthetic appearance of the patient's face: a convex or concave profile, an unpretty smile, availability of a sagittal overjet between the jaws, speech impairment and open-mouth breathing, narrowing of the supramaxillary base, narrow Gothic palate[6] and malocclusion[4]. Obviously, this type of impairment has a skeletal and dentoalveolar nature that requires different treatment approaches to achieve a good result[7]. In order to achieve a satisfactory, aesthetic and functional result, the orthodontist needs to carefully analyze the diagnostic data, pay attention to all the morphological structures of this impairment and not to make mistakes that may deliver the inconvertible results when planning the treatment stages[11].

Most studies demonstrate that the incidence of sagittal occlusion abnormalities depends on the age of the patient[1], since some researchers believe that the incidence of occlusion abnormalities varies from 7 to 10 years at the early stages of mixed dentition[10]. It should be taken in into account that, most often, in addition to the functional maximum, adolescents and adult patients expect the maximum aesthetic result[6] from orthodontic treatment, which affects their psychosocial status in positive way[8].

In that respect, it seems promising to review the diagnostic and therapeutic measures aimed at improving the quality indicators of orthodontic care for children.

The development of the approach that is closest to the diagnostics and treatment of occlusion abnormalities to achieve an acceptable result, combined with the excessive growth of the upper or lower jaw and the anterior position of the supramaxillary dentoalveolar complex will help to achieve a stable aesthetic outcome during the treatment and avoid relapse. Therefore, the modern method of eliminating the factors affecting the normal dentofacial system formation are relevant.

The aim of this study is to determine the early latent forms of occlusion anomalies in children and to substantiate the effectiveness of treatment and preventive measures.

Materials and Method

The study is based on data from a survey of 90 patients during the period of mixed (6-12 years) and permanent dentitions (13-18 years), with the average age 13.4±0.3 years. 52 children (57.8%) had the posterior occlusion, and 38 - the anterior occlusion (42.2%). In order to compare the results obtained for the patients in the examined groups, we used the control group consisting of 19 children with the orthognathic occlusion.

The diagnosis was determined on the basis of data from the history of clinical, biometric, radiological examination of the patients, in accordance with the diagnostic criteria.

The clinical examination included a survey, facial and dental examination. The etiological and pathogenetic factors were identified that contributed to the malocclusion occurrence and development in the sagittal plane. During the facial examination, the attention was paid to the symmetry of its left and right halves, the intensity of the nasolabial and genial folds, and lip seal with the rest position of the mandible.

The particular attention was paid to the identification of morphological and functional disorders that led to the occurrence of a gap between the upper and lower dentitions in the frontal area, and a decrease in the height of its lower part.

In order to determine the structural features of the facial skull, and to determine the changes in the sagittal dimensions of the facial skull, the lateral teleroentgenograms of the patients' heads have been studied, as a result of orthodontic treatment.

On the basis of clinical examination, anthropometric measurement data of diagnostic maxillary models and analysis of the head teleroentgenograms performed in a lateral projection, the diagnosis and the treatment plan have been determined.

The orthodontic treatment consisted of the use of removable intraoral and extraoral devices (myobraces, cervical bandage, Delaire face mask, non-removable device for maxillary expansion), and edgewise techniques based on the brace systems of foreign manufacturers. The dentition correction was performed by the straight-wire technique of the Roth system. The results of instrumental correction controlled on the stone models determined the ability to complete the elimination process for the dentition occlusion abnormality and form the orthognathic occlusion.

Treatment stages for patients of the 1st study group with the distal occlusion:

1. **Early mixed dentition - 6-9 years:**
   - myobrace;
   - cervical bandage;
   - rapid maxillary expansion device.
2. **Late mixed dentition - 10-13 years:**
   - cervical bandage;
   - rapid maxillary expansion device;
   - braces with tooth extraction.
3. **Permanent dentition - 14-18 years:**
   - cervical bandage;
   - rapid maxillary expansion device;
   - braces with tooth extraction.

Treatment stages for patients of the 2nd study group with the distal occlusion:

1. Early mixed dentition - 8-12 years;
   - Frankel functional regulator;
   - high pull;
   - rapid maxillary expansion device.
2. **Late mixed dentition - 12-14 years:**
   - high pull;
   - rapid maxillary expansion device;
   - braces with removal of the upper first premolars.

3. Permanent dentition - 14-18 years:

- high pull;
- rapid maxillary expansion device;
- braces with removal of the upper first premolars.

Treatment stages for patients of the 1st study group with the anterior occlusion:

1. Early mixed dentition - 6-9 years:
   - myobrace;
   - Delaire face mask;
   - rapid maxillary expansion device.
2. Late mixed dentition - 10-13 years:
   - Delaire face mask;
   - rapid maxillary expansion device;
   - braces with the removal of the first premolars.
3. Permanent dentition - 14-18 years:
   - Delaire face mask;
   - rapid maxillary expansion device;
   - braces with removal of the lower first premolars.

Treatment stages for patients of the 2nd study group with the anterior occlusion:

1. Early mixed dentition - 8-12 years:
   - head-chin strap;
   - Frankel functional regulator;
   - plate with an inclined plane;
   - Delaire face mask.
2. Late mixed dentition - 12-14 years:
   - head-chin strap;
   - Frankel functional regulator;
   - Delaire face mask;
   - braces with removal of the lower first premolars.
3. Permanent dentition - 14-18 years:
   - head-chin strap;
   - Delaire face mask;
   - braces with removal of the lower first premolars.

The data obtained were subjected to statistical processing using the statistical analytic application software package with the calculation of arithmetic mean (M), mean square deviation (σ), standard error (m), and relative values (frequency, %). The confidence level of $P<0.05$ was accepted as the statistically significant changes.

Results

The clinical examination have revealed that 79 patients (87.8%; 79/90) were not previously consulted by an orthodontist and only 11 (12.2%; 11/90) performed regular medical check-ups. With that, the patients used the removable orthodontic appliances, but the treatment was not completed, for various reasons.

The prevalence of dentofacial anomalies is relatively more common with the mixed dentition than with the permanent dentition (42.2% versus 57.8%), however, the statistical analysis has showed that these differences are unreliable ($P>0.05$). When assessing the condition of the dentition and alveolar processes, the change in the dental arch (upper and lower) shape was determined. The maxillary V-shaped and trapezoidal, and the mandibular trapezoidal abnormal forms mainly predominated.

When analyzing the patient profiles, we found that in most cases, the children at the age of 6-12 years had a convex facial profile. Moreover, this effect occurs with almost the same frequency both in the case of the submaxillary underdevelopment and the maxillary overdevelopment. In the case of the submaxillary overdevelopment and the maxillary underdevelopment, the straight and concave profile was observed in children at the age of 6-12 years. In children at the age of 13-18 years with the distal occlusion, the convex profile was observed in all cases, while the children with the anterior occlusion had the concave profile.

During the analysis of the intraoral photographs, we identified the following specific features of the submaxillary development. 39 children at the age of 6-12 years had the specific features of the submaxillary retromolar area, among which 19 children had the alveolar crest narrowing, and 20 children showed the prominence of the retromolar area.

As a result, the data specifying the lack of space or dentition excess in the patients have been obtained. In the case of lack of space in the mandible, the alveolar crest shape of the retromolar surface of eruption of the submaxillary second molars is ill-defined and narrow. The reverse effect is observed in the children at the age of up to 9 years: the more thickened the alveolar process crest, the closer the second molar germ is located to the eruption, thus, the clinical evidence demonstrates the excessive submaxillary growth and a wide submaxillary apical base (Fig. 1).

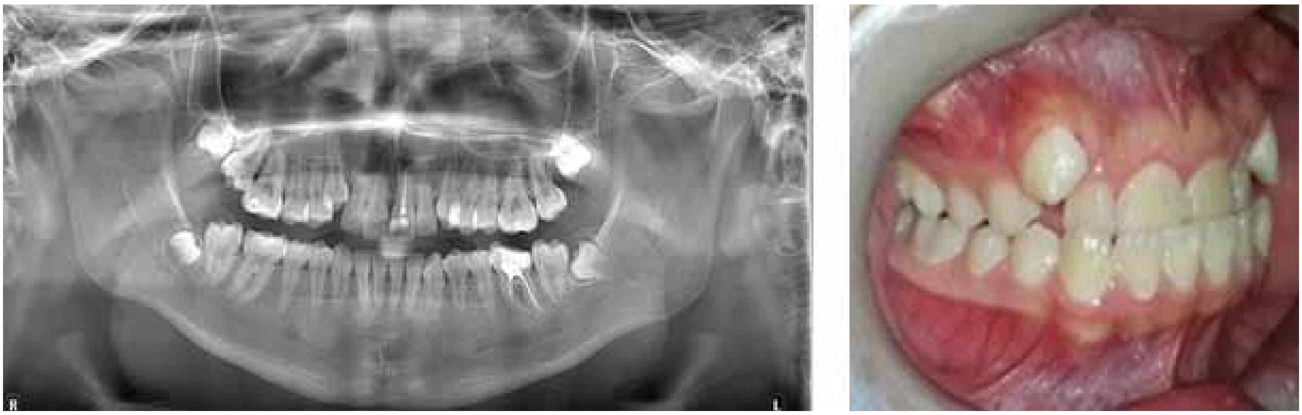

Fig 1. Premature eruption of the lower second molars resulted in excessive submaxillary growth (the patient is 11 years old).

Therefore, among the analyzed orthopantomograms, the largest number of patients with the delayed eruptions of the second molars is at the age of 12 to 14 years old, with the premature eruptions from 8 years to 11 years old. The severity of teeth overcrowding in the case of delayed eruptions of the second supramaxillary molars is increased with aging. The older the patient, the more difficult it is to prevent the anomaly development and occlusion deformation and vice versa.

In summing it up, it may safely be said that the computed tomography with 3D reconstruction forms the modern diagnostic method for anterior occlusion. The anterior occlusion treatment for the adolescents is possible without surgical intervention during early mixed dentition when using the extraoral devices (Delaire face mask), based on the growth modification, applied forces and with the false anterior occlusion.

The other reasons for the anterior occlusion development include the following: maternal illnesses during pregnancy, birth trauma, underdevelopment of the intermaxillary bone, maxillary adentia, retention and loss of the upper teeth, supernumerary teeth in the lower jaw, delayed second dentition, various children diseases, shortening of the lingual frenulum, hypertrophy of the palatine and lingual tonsils, macroglossia, bad sucking habits and some other bad habits, uneven abrasion of the temporary tooth cusps and uneven second dentition on the upper and lower jaws, irregular teeth position, infantile swallowing type, impaired tongue articulation during speech, acromegaly, impaired miodynamic balance (Fig. 2).

Fig 2. Occlusion contact disruption with the combined occlusion anomaly: anterior occlusion and cuspidate dystopia caused by excessive maxillary development and the submaxillary underdevelopment

Occlusively, the anterior molar contact in the sagittal plane (50% - 25 patients) prevailed with the neutral Angle's molar occlusion (50% - 25 patients). The palatine occlusion has been found in 20 patients (40%), and vestibulo-occlusion - in 11 patients (22%).

The teeth abnormalities in the transversal plane has been diagnosed in 62% of cases of the dentition anterior occlusion. In the frontal area, the incisor invert correlation has been detected in 23 patients (46%), sagittal mismatch has been diagnosed in 10 patients (20%), and direct occlusion - in 2 patients (4%).

In 50% of cases, there was a decrease in percent of the angle indication between the mandibular plane and the Frankfurter plane (25.43% - 25.27%). The mismatch in the relations between the upper and lower jaws was (79.7% - 80.13%). The indicators before and after the distal occlusion treatment in percent were equal to 112.7% - 116.4% (Table 1).

Table 1: Cephalometric study results among the examined patients

	Normal range	Before treatment	After treatment
FMIA	67±0,01	63,23±1,17	65,30±1,31
FMA	25±0,01	25,43±0,83	25,27±0,41
IMPA	88±0,02	89,27±1,26	88,37±0,73
AO-BO	2±0,0 мм	0,88±0,99	1,59±0,40
SNA	79±0,01	79,77±0,79	80,13±0,53
SNB	77±0,01	78,15±0,61	78,80±0,45
ANB	2±0,0	4,93±1,19	3,57±0,72
Effec. max. lengh	85±0,01	93,03±1,25	94,42±1,09
Effec. mand. lengh	105±0,01	112,69±1,61	116,37±0,90
Upper pharynx	8,58±0,65	8,78±0,61	8,58±0,65
Lower pharynx	11,23±0,50	12,25±0,65	11,23±0,50

An analysis of the parameters specifying the facial soft tissue profile has revealed an increase in the nasolabial angle of 15.8%, its decrease with the distal ratio of 25%, a decrease in the convexity angle of soft tissues and a decrease in the facial profile convexity of 33% with an anterior dentition relation. In summing it up, it is safe to say that the cephalometric data in lateral projection is the modern anterior occlusion diagnostic method. The anterior occlusion treatment for adolescents is possible without surgical intervention during the early mixed dentition using the extraoral devices (Delaire face mask) based on the growth modification, applied forces and with the false anterior occlusion.

Determination of the first maxillary premolar germ migration on a cephalometric image. According to Beamler's data, in the non-growing patients with the harmonious facial development and a normally formed permanent orthognathic occlusion, the 'stress axis' passes through the vertical axis of the first maxillary premolar. If the erupting first premolar was in front of the stress axis, it was indicated to remove the first premolars, and the cases of posterior position indicated the maxillary underdevelopment (Fig. 3).

Determination of the first maxillary premolar germ migration on the profile teleroentgenogram. 16 children at the age of 6-9 years old with the early clinical signs of sagittal abnormalities were subjected to cephalometric analysis of the upper premolar germ position. As a result, 7 children showed the anthroposition of the first premolar germs that was an early latent sign of rapid maxillary development or early migration of the upper posterior teeth (Fig. 4). 9 children demonstrated the retroposition of the first premolar germs being an early latelt sign of the delayed maxillary development, the distal position of the upper permanent posterior teeth germs or excessive supramaxillary development (Fig. 5).

Fig. 3. Determination of the first maxillary premolar germ migration on the profile teleroentgenogram

Fig. 4. Position of the upper premolar germs: a child at the age of 7 years

Fig. 5. Retroposition of the first premolar germs: a child at the age of 9 years

In some cases, the doctor may need a CT scan. This image only allows to estimate the spatial teeth arrangement relative to each other. This is necessary when planning the impaction movement, when it is extremely important to understand which tooth is located more superficially, and to select the right displacement vector so as not to touch the roots of other teeth. When using the OPTG, an assessment of the tooth position is possible only in one – frontal - plane.

In the course of the therapeutic measures performed for the children and adolescents, the neutral relations of the first molars according to Angle's class I was achieved. When evaluating the treatment outcomes, we noted the coincidence of the central line between the upper and lower teeth, formation of an interincisal angle within 118° and overlapping by the upper incisors of more than 1/3 of the height of the lower incisors.

The high level of satisfaction of the patient and his/her parents with the treatment results made it possible to positively evaluate its results. The formation of physiological dentition occlusion increased the chewing function efficiency. The results are presented in Table 2.

One year after the follow-up commencement, we recorded an increase in the number of people with physiological occlusion in the second group - in children who used a cervical bandage and non-removable orthodontic appliances. After two years, the treatment efficiency in children in the second group reached a maximum value that had a significant difference with the treatment results after one year. However, this indicator differs significantly from the similar indicators in the comparison group.

Table 2: Dentition condition dynamics during the treatment process

Treatment terms	Physiological occlusion				Anomaly at the formation stage				Formed abnormality			
	Control group		Comparison group		Control group		Comparison group		Control group		Comparison group	
	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Commencement of treatment	0	0	0	0	13	52	11	44	12	48	14	56
After 1 year	15	60	11	44	8	32	8	32	2	8	6	24
After 2 years	23	92	17	68	1	4	6	24	1	4	2	8
After 6 years	24		19		1		7		1		7	

After 24 months of active treatment, the malocclusion was corrected in the control group in 90% of cases, and in the comparison group - in 78% of cases. The patient profile was significantly improved, and the intermaxillary deviation was readjusted. The upper jaw was placed in its natural position. The cephalometric images showed the clear pattern of the correct maxillary growth direction in 23 patients (92%) of the control group and in 20 patients (80%) of the comparison group (Fig. 6).

The treatment results after two years show that in 92% of patients in the control group, occlusion stability was preserved, and the facial profile also remained aesthetically pleasing. In the comparison group, the stability was maintained only by 68% of children.

Therefore, the orthodontic treatment success in the growing patients with class II malocclusion depends on its growth direction and the appropriate selection of treatment time. That is why it is important to diagnose an early accurate diagnosis, the degree of skeletal discrepancies, in order to prepare a treatment plan that is most suitable for the patient.

Class II or bite elastics can be used simultaneously and assist in changing the dentofacial growth direction. The combination of a cervical bandage is an effective approach to the early treatment of skeletal impairments. In addition, the achieved correct anterior teeth occlusion from the anterior position of the upper teeth and jaw has contributed to the mandibular growth.

Analysis of the study showed that in the control group of patients, in 94% of cases we achieved the good treatment results, in 6% - satisfactory, and in 0% - negative. In the comparison group, it was 68%, 24% and 8, respectively. The patients from the control group have also demonstrated a 3-fold increase in the treatment efficiency.

Fig. 6. Intraoral images of a patient with prognathia (a) before treatment, (b) after treatment, (c) 7 years after treatment

During the repeated studies, we found that in patients of the control group the relapses occurred in 6.7% of cases (3 patients), while in the experimental group - in 20.0% (9 patients).

Therefore, during the treatment process for the dentition distal occlusion, it is sustainable to use the proposed treatment with myofunctional devices such as myobrace, a non-removable maxillary expansion plate with a cervical bandage for the upper jaw and without certain teeth extraction. That allows to expand the upper dentition, while providing the lower jaw with the constructional occlusion.

Discussion

In most cases, the high occurrence of dentofacial abnormalities in children is characterized by the availability of morphologically immature structures. This opinion is supported by T.F. Vinogradova [1] and other researchers. According to T.F. Vinogradova, an eight-year-old child has a simultaneous growth of the coronal section of permanent molars, the premolar root system against the background of changes of the temporary molars that indicates the availability of various tissue maturity degrees. It is also noted that under the same influence of external and internal factors, the different forms and growth reactions are noted[3, 5].

According to our data obtained, the prevalence of dentofacial anomalies is relatively more common with the mixed dentition than with the permanent dentition (42.2% versus 57.8%). Gowever, the statistical analysis showed that these differences are unreliable (P>0.05).

According to the research performed by Listopadov M.A. et al., it has been found that the use of tomography allows to determine the anatomical and topographic features of the temporomandibular joints with the distal occlusion. This data must be considered during the treatment of patients with this impairment [4].

As a result, we have obtained data characterizing the lack of space or excess dentition in the patients. In the case of lack of space in the mandible, the alveolar crest shape of the retromolar surface of eruption of the submaxillary second molars is ill-defined and narrow. The reverse effect is shown by the children at the age of up to 9 years: the more thickened the alveolar process crest, the closer the second molar germ is located to the eruption. In such a way, the clinical evidence demonstrates the excessive submaxillary growth and a wide submaxillary apical base.

Voskanyan A.R. developed and implemented the express diagnostics of deviations in the teeth position, shapes and dimensions of the dental arch and its segments from the individual normal values. It is based on the use of template sets that provide complete information on monitoring the orthodontic treatment results [2]. Our data show that the severity of teeth overcrowding with the delayed eruption of the submaxillary second molar is increased with aging. The older the patient, the more difficult it is to prevent the development of occlusion abnormalities, and vice versa.

The delayed treatment of abnormal changes in the primary and mixed dentitions contributes to the formation of severe dentofacial abnormalities in the case of permanent dentition [3, 5], while the treatment initiated at the early stages reduces the implementation of comprehensive orthodontic treatment, including the permanent teeth extraction [7, 9]. In the course of our treatment of the dentition distal occlusion, it is sustainable to use the proposed treatment with the removable extraoral and intraoral devices with the cervical bandage for the upper jaw, with and without the certain dental extraction. All above allows to expand the upper dentition, while providing the lower jaw with the constructional occlusion.

Conclusions

1. The cephalometric indicators in the early diagnosis of sagittal occlusion in children helps to obtain the proper treatment planning and achieve the consistent long-term results. Due to the early diagnostics and treatment of sagittal occlusion anomalies, a significant improvement in aesthetics can be achieved.

2. Among the analyzed orthopantomograms, the largest number of patients with the delayed eruptions of the second molars is at the age of 12 to 14 years old, with the premature eruptions from 8 years to 11 years old. The severity of teeth overcrowding in the case of delayed eruptions of the second supramaxillary molars is increased with aging. The older the patient, the more difficult it is to prevent the anomaly development and occlusion deformation, and vice versa.

3. During the treatment process of the dentition distal occlusion, it is sustainable to use the proposed treatment with the removable extraoral and intraoral devices with the cervical bandage for the upper jaw, with and without the certain dental extraction. All above allows to expand the upper dentition, while providing the lower jaw with the constructional occlusion.

4. The economic efficiency of the proposed treatment method is aimed to reduce the number of relapses of this impairment by almost 3 times.

Ethical Clearance: No ethical approval is needed.

Source of Funding: Self

Conflict of Interest: Nil

References

1. T.F. V. Preventive medical examination of children by the dentist. Moscow, Medicine. 2008; 2.
2. Voskanyan AR. Issues and prospects of care delivery for children with the dentofacial anomalies. Medical Bulletin of the North Caucasus. 2016; 3: p. 452–456.
3. E.A. K. Early individual prediction of dentofacial anomalies in the primary school-aged children. Social aspects of public health. 2015.
4. Listopadov MA. Using tomography to diagnose the anatomical and topographic changes in the

temporomandibular joints with distal occlusion. Saratov Journal of Medical Scientific Research. 2011; 1: p. 307-308.

5. Popova ES, KYV. Orthodontic incidence structure in children living in Chita during the temporary occlusion period. Doctoral student. 2013; 60 (5): p. 89-92.
6. Kurokawa M,KH,TH. The main occluding area in normal occlusion and mandibular prognathism. Angle Orthod. 2016; 86 (1): p. 87-93.
7. Mazzini WU,TFM. Orthodontic Camouflage: A Treatment Option - A Clinical Case Report. Contemp Clin Dent. 2017; 8(4): p. 658-661.
8. Mousoulea S,TI,FE. The Effect of Chin-cup Therapy in Class III Malocclusion: A Systematic Review. Open Dent J. 2016; 9(10): p. 664-679.
9. Neskoromna-Jędrzejczak A,BK,AB. How Do Patients Assess Outcomes Of Treatment Of Prognathism? Pol Przegl Chir. 2015; 87 (8): p. 395-401.
10. Papageorgiou S,KE. Effectiveness of early orthopedic treatment with headgear: a systematic review and meta-analysis. Eur J Orthod. 2017 Apr 1; 39(2): p. 176-187.
11. Paul S,RA,CP. Fixed Appliance with Expansion Screw for the Treatment of Primary Anterior Crossbite. 2016; 10(5): p. ZD03-4.