MEDICAL UNIVERISTY - PLOVDIV

FACULTY OF DENTAL MEDICINE

DEPARTMENT OF ORTHODONTICS

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Comparative assessment of the therapeutic effect of the application of class II elastics and myofunctional appliances in the correction of class II 1 malocclusion

Abstract of

The dissertation for the

educational and scientific degree "Doctor"

Scientific specialty: Orthodontics

Supervisor:

Assoc. Prof. Dr. Silviya Krasteva, PhD

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The dissertation contains 194 pages and is illustrated with 27 tables and 50 figures. The references include 242 literature sources, 16 of which are in Cyrillic and 226 in Latin.

The dissertation was discussed and proposed for defense by the Department Council at the Department of Orthodontics at the Medical University of Plovdiv, where the PhD student is enrolled for independent training.

The public defense of the dissertation is scheduled on 21.07.2022 at 11:00 am in the Second Auditorium Hall of the Auditorium Complex of MU - Plovdiv, 15A Vasil Aprilov Blvd. according to the Regulations on the terms and conditions for obtaining scientific degrees and knowledge and acquiring an academic position at MU-Plovdiv and Order № P-1113 / 16.05.2022 of the Rector of MU-Plovdiv before a scientific jury composed of:

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Note: In the abstract the numbers of the tables and figures do not correspond to the numbers in the dissertation.

CONTENTS

Abbreviations

DMD – dento-maxillary deformities

AFH - anterior facial height

PFH - posterior facial height

MM - intermolar distance

PP - interpremolar distance

CC - intercanine distance

$\bar{X}$ - mean value;

SD - standard deviation;

I. INTRODUCTION

Class II malocclusion is one of the most common dento-maxillary deformities (DMD), which over time has allowed its detailed study and the creation of a wide range of methods for its treatment. As a problem that affects a large percentage of orthodontic patients, accurate diagnosis and selection of the most appropriate correction method according to the specific subtype of malocclusion are of paramount importance for any specialist.

There are three main approaches to the correction of this skeletal deformity depending on its severity and maturation age of the patient - orthopedic, surgical-orthodontic and orthodontic-surgical. The first method includes functional and extraoral appliances and their independent or combined usage depends on the specific type of the class II malocclusion.

In the majority of cases the distal bite is due to retromandibulia (distal position of the lower jaw), the correction of which requires medial displacement and/or stimulation of mandibular growth. A wide variety of removable and fixed functional appliances are successfully used in everyday practice to achieve this orthopedic effect. This group of orthodontic appliances utilize the activity of the facial and masticatory muscles to change the position and relationships of individual teeth, dental arches and jaws. The first such devices were created more than a century ago. With the introduction of new materials in medicine and the accumulation of more and more knowledge about the physiology of the maxillofacial region and the phases of human development new appliances for the treatment of class II malocclusion are created and the existing ones are evolving.

Myofunctional appliances (myotrainers) are contemporary silicone prefabricated devices whose design not only allows for correct three-dimensional positioning of the jaws, but also for the improvement of vital functions in the orofacial complex such as breathing, chewing, swallowing etc. by affecting the soft tissue matrix. Following the worldwide trend for reducing the treatment time, modifications of these appliances have been created, which can be applied in combination with a fixed technique.

We chose to focus our study on the comparative assessment of the therapeutic effects of Class II elastics and EF Braces trainer (EF Line, Orthoplus), as both are used in combination with the most popular fixed technique today. Intermaxillary traction with class II elastics is routinely used to correct distal bite at dento-alveolar and skeletal level. On the other hand, the main principle of action of EF Braces is the medialization of the lower jaw by stimulating the propulsor muscles of the mandible and by growth in the condylar process. The specific design of this appliance allows for the correct positioning of the tongue, normalization of the tonicity of the lower lip and m. mentalis and freeing of the neutral zone in the lateral part of the oral cavity from muscle pressure. Due to these effects the myofunctional appliances also contribute to the normal and synchronous growth of the alveolar arches and jaws and improve the facial profile. They have a beneficial effect on the development and function of the temporomandibular joints and aid in the final positioning of the front teeth. Last but not least, patients today have high esthetic demands and are looking for options that do not disturb their social life. As these appliances are worn only at home, they are well accepted by patients and their cooperation at the proper treatment stage is crucial to achieve stable clinical outcome.

The aforementioned advantages of the EF Braces appliance and the lack of sufficient research on its action in the available literature prompted us to make an in-depth study on its effects. Detailing the clinical possibilities of this myofunctional device allows us to determine the range of its orthodontic and orthopedic effects.

II. AIM AND PROBLEMS

The **aim** of this dissertation is to compare the dento-alveolar and skeletal effects of the application of class II elastics and EF Braces myotrainer in growing patients with class II 1 retromandibulia in the main treatment phase with fixed technique.

To achieve this aim we set the following **problems**:

1. To make a comparative cephalometric assessment of sagittal skeletal and dento-alveolar parameters in the treatment of class II 1 malocclusion with class II elastics and myofunctional appliances in achieving class I relationships.

2. To compare the vertical skeletal cephalometric changes between the two treatment methods.

3. To determine the changes in the transverse dimensions of the upper and lower dental arches on orthodontic models in the studied treatment modalities.

4. To create a model for predicting the treatment duration and the expected changes according to the skeletal age and vertical type of growth when using myofunctional appliances.

III. MATERIAL AND METHODOLOGY

III.1 Material.

The study consisted of 70 Bulgarian patients aged between 10 and 16 years (mean age 13.45 ± 2.17) treated in the postgraduate practice of the Department of Orthodontics at the Faculty of Dental Medicine, Medical University - Plovdiv and the private practice of the doctoral student for a period of 3.5 years.

Inclusion criteria for selection of patients:

- ✓ Patients with distal bite, class II division I with $4^o \leq ANB \leq 8^o$;
- ✓ Have not had previous orthodontic treatment
- ✓ The treatment should be non-extraction and the patients should be without hypodontia;
- ✓ Have agreed to a treatment plan that includes vestibular fixed technique
- ✓ Patients should be in early or formed permanent dentition;
- ✓ To be motivated for treatment with removable appliances.

The study contingent of patients was divided into two equal groups according to the treatment modality.

Group 1: Patients treated with class II elastics

Group 2: Patients treated with the EF Braces appliance

All patients had their upper and lower impressions taken with alginate and a wax bite registration and profile cephalograms were taken before starting treatment with Class II elastics and EF Braces and after class I molar relationships were reached. All plaster models and profile cephalograms were thoroughly analysed according to the needs of the study.

11 linear and 12 angular cephalometric parameters were examined before and after the treatment of the 70 patients. A total of 3220 measurements were made. On the initial and final plaster models (140 in total), 6 metric parameters were measured in all 70 patients. 840 measurements were made.

Patients in both groups had similar values in terms of age, sex and growth stage (Table 1).

Table 1: Patient characteristics

Variables	EF Braces appliance (N = 35)	Class II elastics (N=35)	p
Age			
○ Mean (±SD)	13.06 (±2.19)	13.83 (±2.15)	
○ Median	13	13.50	0.142^{t}
○ Min-Max.	10 - 16	11 - 16	
Sex (N, %)			
○ Men	16 (46%)	18 (51%)	0.811^{f}
○ Women	19 (54%)	17 (49%)	
Treatment duration (months)	13.37 (±4.41)	10.34 ±(4.49)	
○ Mean (±SD)	13	9	0.003^{U}
○ Median	5-27	5-21	
○ Min-Max.			
Maturational stage (N, %)	4 (12%)	1 (3%)	
○ II	9 (26%)	7 (20%)	
○ III	11 (31%)	15 (43%)	$0.439^{\chi 2}$
○ IV	11 (31%)	12 (34%)	
○ V			

t: Arithmetic mean; SD: standard deviation; t: t-test for independent samples; f: Fisher's test; $\chi 2$: Chi-square test

Some of the materials for the conducted research were provided via the University Project NO 01/2019. The studies were approved by the Ethics Committee No. 4760 / 02.07.2020 and Protocol No. 6 / 09.07.2020.

III.2 Methods.

IV.2.1. Clinical protocol

MBT 0.22' braces were fixed in the upper and lower jaw, as well as buccal tubes or molar bands on the first molars. Second molars were not included in the system in order to achieve comparability of results, as not all patients had them. After levelling the upper and lower dental arches, thick stainless steel arches were placed, which were inserted in the bracket slot in both jaws without tension. Thus, before proceeding with the correction of class II, stability of the individual arches was achieved.

At this stage, at the beginning of the adjusting phase, upper and lower control and diagnostic impressions were taken from all 70 patients. Profile cephalograms were done prior to the inclusion of the Class II elastics or EF Braces appliance to study their specific effects.

The first group of patients treated with intermaxillary traction was given a package of elastics with a size of ¼ ‘and heavy strength of 6.5 oz. Patients were instructed to place them on the buccal tube or molar band on the lower first molar and the bracket hook on the upper canine on both sides. These elastics were prescribed to be worn the whole day, to be removed only for food and hygiene, and changed daily.

The second group of patients was given a prefabricated silicone appliance EF Braces. They were instructed to wear it according to the following scheme:

1. The first 7-10 days - 3-4 hours during the day, which could be divided into intervals of one hour or less to get used to the myotrainer. This was the adaptation period.

2. Then they had to wear it for 12 hours per day. This time period included night wear, and the daily wear could be at intervals with breaks between them until the required duration was reached.

All patients were instructed to come for follow-up examinations every 4-5 weeks. After reaching class I molar relationships, control impressions were taken again and control profile cephalograms were performed.

IV.2.2. Linear and metric methods for evaluation of lateral cephalogram and plaster models

The initial and final lateral cephalograms were digitally traced using the orthodontic software program AudaxCeph (Fig. 1). For the purposes of the dissertation certain angular and linear parameters were selected, which most accurately correspond to the aim and problems.

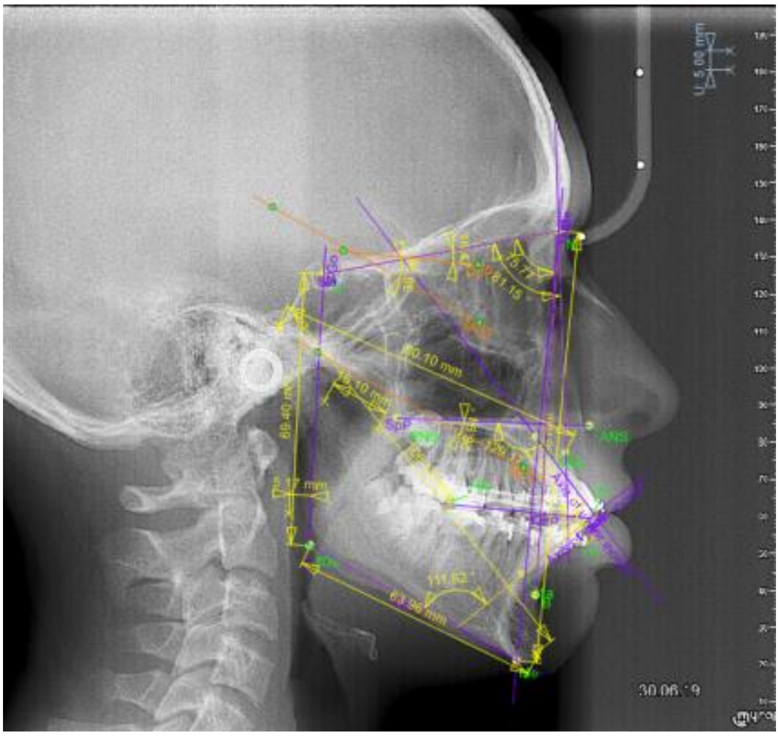

Fig.1 Traced lateral cephalogram using AudaxCeph software program.

Problem 1: To make a comparative cephalometric assessment of sagittal skeletal and dento-alveolar parameters in the treatment of class II 1 malocclusion with class II elastics and myofunctional appliances in achieving class I relationships.

<u>Angular sagittal skeletal parameters:</u>

∢ SNA - 82^{o}-84^{o} were accepted as reference values;

∢ SNB - 80^{o}-82^{o} were accepted as reference values;

∢ANB - 0^{o}-4^{o} were accepted as reference values.

<u>Linear sagittal skeletal parameters</u>:

AoBo - Wits appraisal. -2 to + 2 mm were accepted as reference values;

Co-A - Effective midfacial length - an indicator taking into account the effective length of the middle part of the face from point Co to point A in mm;

Co-Gn - Effective mandibular length - an indicator taking into account the effective length of the lower jaw from point Co to point Gn in mm;

Go-Gn - length of the lower jaw from Go to Gn in mm.

Upper pharynx - from the posterior contour of the soft palate to the nearest point of the pharyngeal wall. 15 to 20 mm were accepted as reference values;

Lower pharynx - from the intersection of the posterior contour of the tongue with the lower edge of the lower jaw to the nearest point of the pharyngeal wall. 11 to 14 mm were accepted as reference values;

Angular dental parameters:

∢I / SpP - Reference values - 110^o +/- 5^o;

∢I / Sn - Reference values - 102^o-105^o;

∢I / NA - Reference values - 22^o;

∢i / MP - Reference values - 85^o-95^o;

∢i / NB - Reference value - 25^o;

Linear dental parameters:

I-NA - a parameter reading the sagittal position of the upper incisor relative to the NA line in mm (4 mm).

i-NB – a parameter reading the sagittal position of the lower incisor relative to the NB line in mm (4 mm).

Problem 2: To compare the vertical skeletal cephalometric changes in the two treatment methods.

Angular vertical parameters:

∢MP / Sn - 29^o-35^o were accepted as reference values;

∢Mn / SpP - 22^o-28^o were taken as reference values;

∢OcP / Sn - -14^o-16^o were taken as reference values.

Linear vertical parameters and ratios

N: Me - Anterior facial height (AFH).

S: Go - Posterior facial height (PFH).

S: Go / N: Me - Jaraback index. Values between 62% and 65% were accepted as the norm.

Problem 3: To determine the changes in the transverse dimensions of the upper and lower dental arches on orthodontic models in the studied treatment modalities

We used plaster models to assess changes in the transverse dimensions of the upper and lower jaw before and after treatment of class II malocclusion. We measured the intercanine, interpremolar, and intermolar distances in the upper and lower jaws with accuracy up to 1 decimal place using a digital caliper (Fig.2)

FIG. 2. Digital caliper (Hammacher D-42699, Solingen, Germany)

<u>Intercanine distance (C-C):</u>

To measure the intercanine distance, we used the point on the center of the palatal surface gingivally by Andreeva(Fig. 3). The choice of this reference point in our study was dictated by its stability and reproducibility when considering transverse measurements in different patients.

To measure the interpremolar and intermolar distance, we used the Pont method of standard biometric analysis (Fig. 3). The parameters were measured in mm.

<u>Interpremolar distance (P-P):</u>

PP for the upper jaw was measured in the middle of the central fissure of the first upper premolars.

PP for the lower jaw was measured at the point of contact between the first and second lower premolars vestibularly.

<u>Intermolar distance (M-M):</u>

MM for the upper jaw was measured in the central fissure below the mediovestibular cusp of the upper first molar.

MM for the lower jaw was measured at the tip of the second vestibular cusp of the first lower molar.

FIG. 3. Plaster models of the upper and lower jaw, linear measurement of the transverse dimensions of the dental arch: A - measurement of intercanine distance; B - measurement of interpremolar distance; B - measurement of intermolar distance

IV.2.3. Determination of bone age of patients on a lateral cephalogram using Baccetti's method

Nowadays the most common method for identifying the stage of bone growth is the Baccetti's method on a lateral cephalogram. Skeletal maturation is assessed according to the degree of change in the morphology of the cervical vertebrae (CVM - cervical vertebrae maturation). The two variables that are evaluated by this methodology are the following:

1. Presence or absence of concavity on the lower surface of the bodies of C2, C3 and C4;

2. The shape of the bodies of C3 and C4.

Based on these two criteria, six main stages of morphological maturation of the cervical vertebrae are defined (Fig. 4).

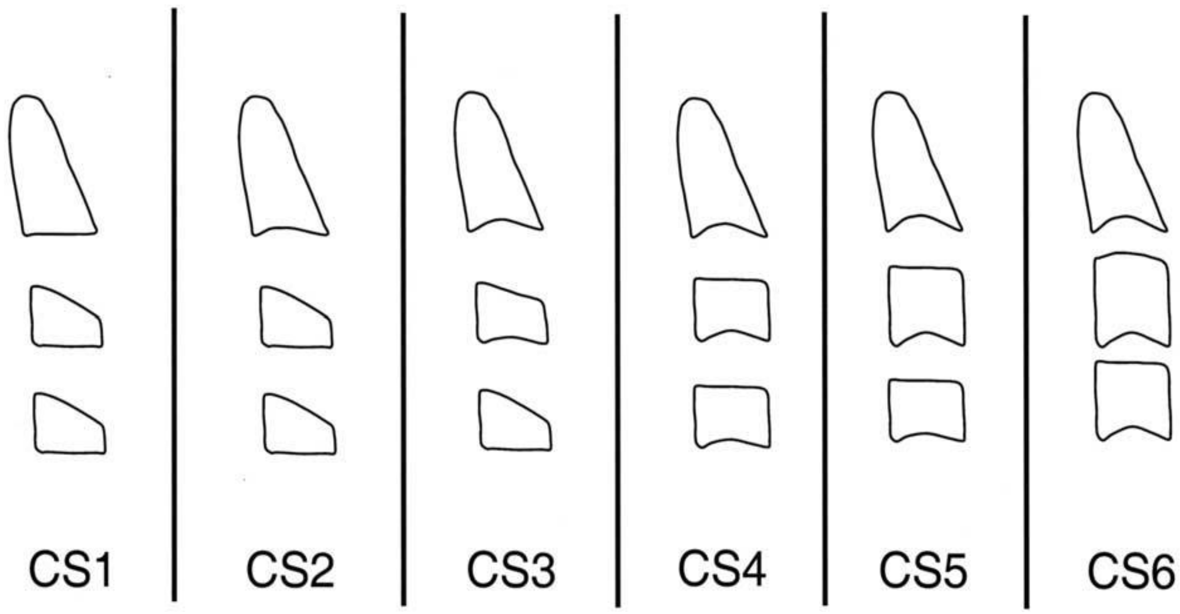

Fig. 4. Schematic representation of the six stages of bone age according to Baccetti.

Stage 1 (CS 1) - The lower surfaces of all cervical vertebrae (C2-C4) are flat, the bodies of C3 and C4 are trapezoidal. The peak of mandibular growth is expected to occur about 2 years after this stage.

Stage 2 (CS 2) – A notch is observed along the lower edge of the body of the second cervical vertebra. The lower surfaces of the cervical vertebrae C3 and C4 are flat and their shape is trapezoidal. The peak of growth of the lower jaw will occur after about a year.

Stage 3 (CS 3) - The lower surfaces of C2 and C3 are concave; the vertebral bodies are trapezoidal or horizontal rectangular (bigger in width than height). The peak of lower jaw growth will occur next year.

Stage 4 (CS 4) - The lower surfaces of the bodies of C2, C3 and C4 are concave. The bodies of C3 and C4 are horizontally rectangular. The peak of mandibular growth occurred within one or two years before this stage.

Stage 5 (CS 5) - the lower surfaces of the bodies of C2, C3 and C4 are concave; the vertebral bodies of at least one of C3 or C4 are square; the other has a horizontally rectangular body shape. The peak of mandibular growth was 1-2 years before this stage.

Stage 6 (CS 6) - the lower surfaces of the bodies of C2, C3 and C4 are concave; the vertebral bodies of at least one of C3 and C4 are rectangular in shape with increased vertical size (bigger in height than width); the other is square in shape. The peak of mandibular growth occurred at least two years before this stage.

According to the authors, the most appropriate stage for the treatment of class II skeletal malocclusion is during the pubertal peak of growth because then the maximum growth response is demonstrated. This period corresponds to stage CS3 and CS4.

For the of **4th problem** each participant in the study had their stage of bone development determined at the beginning of the correction of class II malocclusion according to the methodology described.

IV.2.4. Statistical methods and definition of the visual presentation of the results

The choice of statistical methods was consistent with the objectives of the dissertation and the type of quantities (metric, rank, nominal, dichotomous). The main parameters (sagittal skeletal and dental parameters, vertical angular and linear parameters and transverse dimensions in the upper and lower jaw) were measured on metric scales and are presented with the arithmetic mean and standard deviation (± SD). The intragroup dynamics in these parameters for each treatment method (EF Braces appliance and class II elastics) was monitored by paired-samples t-test.

Intergroup comparisons (between the two treatments) were made by t-test for two independent-samples t-tests. In the absence of similar variability of the change in the target parameters in both methods of treatment, the results of the t-test were reported under the condition of lack of uniformity of variability (equal-variances not assumed). When presenting the data in tables, these cases are marked with a sign! in the column for the value of p.

To clarify the relationship between the change in MP / Sn and the change in OcP / Sn with initial MP / Sn values, according to which patients were categorized into three groups: MP / Sn before treatment <30º; MP / Sn before treatment between 30º and 34º, MP / Sn before treatment > 34º; Spearman rank-order correlation was used before treatment for Problem 2.

In Problem 4, the change in the angular parameters of SNB and ANB, the length of the lower jaw Go-Gn, and the duration of treatment with respect to growth stage and type of growth (Mp / Sn <30º, 30 to 34º, and> 34º) were monitored. For comparison between the different stages of growth and between the categories according to the type of growth, one-way variance analysis (one-way ANOVA) and post-hoc analysis in pairs were performed using the Tukey's HSD post-hoc multiple comparison test. showed a statistically significant relationship with growth stage and / or rate. The prognostic function and the criterion values of the values with significant relationship were established by analysis with ROC curve.

All analyzes were performed at an allowable error level (alpha) of 5% (p <0.5), but the results were graded according to statistical significance as follows: * - significant difference / change at p <0.05; : ** - significant difference / change at p <0.01; *** - significant difference / change at p <0.001. The following statistical programs were used for analysis and graphical presentation of data: IBM SPSS, version 26 (2019), Minitab version 19 (2020) and MedCalc® version 20.008 (2021).

IV. RESULTS

IV.1 Problem 1: To make a comparative cephalometric assessment of sagittal skeletal and dento-alveolar parameters in the treatment of class II 1 malocclusion with the studied appliances after achieving class I relationships.

Results by task 1

IV.1.1 Change in angular sagittal skeletal parameters

EF Braces treatment

The dynamics in the angular sagittal skeletal parameters for the group treated with EF Braces appliance are summarized in Table 2. In ∢SNA there was a decrease in value by -0.12 °, from 82.10 ± 2.79 ° before treatment to 81.98 ± 2.68 ° after treatment, but the change does not reach statistical significance, p = 0.339. A significant increase of 2.10 ° was reported in the angular index ∢SNB, from 76.35 ± 3.13 ° before treatment to 78.45 ± 2.82 ° after treatment, p <0.001. A significant reduction of -2.21 ° was achieved in ∢ANB, from 5.71 ± 2.0 ° before treatment to 3.50 ± 1.76 ° after treatment, p <0.001. This decrease in ∢ ANB is mainly due to the increase in ∢SNB values.

Table 2: Change in angular sagittal skeletal parameters after treatment of class II 1 malocclusion with **EF Braces appliance**

Sagittal skeletal values	**Mean (±SD)**	**Change**		**t-test**
		Difference	95% CI	p
SNA° before treatment	82.10 (±2.79)	-0.12 (±0.69)	-0.12 to 0.35	0.339
SNA° after treatment **(82°-84°)**	81.98 (±2.68)			
SNB° before treatment	76.35 (±3.13)	+ 2.10 (±1.38)	1.62 to 2.57	0.000***
SNB° after treatment **(80°-82°)**	78.45 (±2.82)			
ANB°before treatment	5.71 (±2.00)	- 2.21 (±1.21)	- 2.63 to -1.79	0.000***
ANB° after treatment	3.50			

(2°-4°)	(±1.76)			

X̄: Arithmetic mean; SD: Standard deviation; -: reduction in value after treatment; +: increase in value after treatment; ***: Statistically significant change at p <0.001

Treatment with class II elastics

Data on the change in angular skeletal parameters as a result of treatment with class II elastics are presented in Table 3. The angular parameter ∢SNA shows a significant decrease of -1.95 °, from 83.01 ± 4.68 ° before treatment to 81.05 ± 3.72 ° after treatment, p < 0.001. In ∢SNB, an increase of 0.29 ° was reported, from 77.18 ± 4.48 ° before treatment to 77.47 ± 4.21 ° after treatment, with no statistical significance of the change (p = 0.560). In ∢ANB a significant decrease of -2.24 ° was found, from 5.97 ± 1.40 ° before treatment to 3.72 ± 1.53 ° after treatment, p <0.001. This decrease is mainly due to the decrease in ∢SNA values.

Table 3: Change in angular sagittal skeletal parameters after treatment of class II 1 malocclusion with **class II elastics**

Angular sagittal skeletal parameters	**X̄ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
SNA° before treatment	83.01 (±4.68)	-1.95 (±1.98)	-2.64 to -1.27	0.001***
SNA° after treatment **(82°-84°)**	81.05 (±3.72)			
SNB° before treatment	77.18 (±4.48)	+ 0.29 (±1.72)	-0.42 to 0.76	0.560
SNB° after treatment **(80°-82°)**	77.47 (±4.21)			
ANB° before treatment	5.97 (±1.40)	- 2.24 (±1.28)	-2.68 to -1.80	0.001***
ANB° after treatment **(2°-4°)**	3.72 (±1.53)			

Comparison of the change in the angular sagittal skeletal parameters during treatment with EF Braces appliance and class II elastics

The results of the comparison of the change in the angular sagittal skeletal parameters between the two types of treatment (Table 4) show two significant differences related to the method of treatment. The angular parameter SNA in both treatments showed a reduction in degrees, but with a significantly higher reduction in treatment with class II elastics (-1.95 ± 1.98 °) compared to -0.12 ± 0.69 ° with EF Braces, with difference from - 1.84 ° (p <0.001).

The opposite trend is observed with the change in ∢SNB, where both types of treatment show an increase in values, but in this case the change is significantly greater as a result of treatment with EF Braces (2.10 ± 1.38 °) compared to 0.29 ± 1.72 ° in the treatment with class II elastics, with a difference of 1.81 ° (p <0.001).

In both types of treatment there was a decrease in ANB ° with similar values (EF Braces 2.21 ± 1.21 °; class II elastics - 2.24 ± 1.28) and a minimum difference of -0.028 °, without statistical significance, p = 0.924.

Table 4: Comparison of the change in angular sagittal skeletal parameters in the groups treated with EF Braces and class II elastics

Angular sagittal skeletal parameters	**Treatment**			**t-test**
	EF Braces (N = 35)	Class II elastics (N=35)	95% CI	p
SNA° change **X̄ (±SD)**	-0.12 (±0.69)	-1.95 (±1.98)	1.84 -1.13 до - 2.55	0.000***
SNB° change **X̄ (±SD)**	+ 2.10 (±1.38)	+ 0.29(±1.72)	1.81 1.18 до 2.67	0.000***
ANB° change **X̄ (±SD)**	- 2.21 (±1.21)	- 2.24(±1.28)	0.03 -0.56 до 0.62	0.924

IV.1.2 Change in linear sagittal skeletal parameters

EF Braces treatment

In the group of patients treated with the EF Braces appliance, the linear sagittal skeletal parameters showed significant changes (Table 5) except for the effective length of the middle facial floor Co-A, which reported an increase of

0.58 mm, but no significant change, p = 0.430 . The significant changes are described and illustrated graphically in Table. 5.

Table 5: Change in linear sagittal skeletal parameters with **EF Braces appliance**

Linear sagittal skeletal values (mm)	**Mean (±SD)**	**Change**		**t-test**
		Difference	95% CI	p
A_oB_o before treatment	2.63 (±2.46)	-2.14 (±1.61)	-1.58 to -2.69	0.000***
A_oB_o after treatment **(-2 to +2 mm)**	0.49 (±2.49)			
Co-A before treatment	85.51 (±8.08)	+ 0.58 (±4.09)		-0.82 to 1.99 0.430
Co-A after treatment	86.10 (±6.66)			
Co-Gn before treatment	108.39 (±7.68)	+3.65 (±3.80)	2.35 to 4.96	0.000***
Co-Gn after treatment	112.04 (±6.52)			
Go-Gn before tretament	62.13 (±6.29)	+ 2.85 3.77 (±2.67)	1.93 to	0.000***
Go-Gn after treatment	64.98 (±5.26)			
Upper pharynx before treatment	12.25 (±4.29)	+ 1.95 (±2.44)	0.000***	2.79 to 4.74
Upper pharynx after treatment **(15 to 20 mm)**	14.21 (±3.27)			
Lower pharynx before treatment	9.95 (±3.71)	+ 1.01 0.031* (±2.67)	1.93 to 2.24	
Upper pharynx after treatment **(11 to 14 mm)**	10.97 (±3.11)			

Treatment with class II elastics

In the group of patients treated with class II elastics, changes in linear sagittal skeletal parameters are summarized in Table 6. AoBo decreased from 2.54 ± 2.55 mm before treatment to 1.60 ± 2.02 mm after treatment with a significant change of -0.94 mm, p = 0.016. The effective length of the middle front floor Co-

A also decreased from 87.40 ± 86.88mm to 86.88 ± 5.25mm, with a significant difference of -0.51mm, p = 0.047.

For the other linear sagittal skeletal parameters (Table 6) the changes are not statistically significant. The effective length of the lower jaw Co-Gn increased by 0.65 mm, from 111.14 ± 6.57 mm before treatment to 111.79 ± 7.12 after treatment, but the change did not reach significance (p = 0.062). The length of the lower jaw Go-Gn increased from 68.06 ± 5.46 mm to 68.47 ± 5.49 mm, with a difference of + 0.41 mm, without statistical significance, p = 0.061.

The changes in the Upper and Lower Pharynx are minimal. In the upper pharynx, a decrease of 0.09 mm was reported, from 12.63 ± 2.30 mm before treatment to 12.54 ± 3.06 mm after treatment, p = 0.843. In the Lower Pharynx there is an increase from 0.01 mm from 9.40 ± 2.56 mm to 9.41 ± 2.49 mm, p = 0.967.

Table 6: Change in linear sagittal skeletal parameters with **class II elastics**

Linear Sagittal Skeletal parameters (mm)	**$\bar{X}$ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
A_oB_o before Treatment	2.54 (±2.55)			
A_oB_o after treatment **(-2 to +2 mm)**	1.60 (±2.02)	-0.94 (±2.20)	-0.18 to -1.69	0.016*
Co-A – before treatment	87.40 (±5.25)	- 0.51 (±1.47)	-0.08 to -1.02	0.047*
Co-A after treatment	86.88 (±5.25)			
Co-Gn before treatment	111.14 (±6.57)	+0.65 (±2.01)	-0.03 to 1.34	0.062
Co-Gn after treatment	111.79 (±7.12)			
Go-Gn before treatment	68.06 (±5.46)	+ 0.41 (±1.26)	-0.019 to 0.85	0.061
Go-Gn after treatment	68.47 (±5.49)			
Upper pharynx before treatment	12.63 (±2.30)	- 0.09 (±2.54)	-0.96 to 0.79	0.843
Upper pharynx	12.54 (±3.06)			

after treatment **(15 до 20 мм)**				
Lower pharynx Before treatment	9.40 (±2.56)	+0.01 (±2.01)	-0.67 to 0.70	0.967
Lower pharynx after treatment **(11 до 14 мм)**	9.41 (±2.49)			

Comparison of the change in the linear sagittal skeletal parameters during treatment with EF Braces appliance and with class II elastics

The results of the comparison of the change in the linear sagittal skeletal parameters between the two types of treatment show significant differences in four of the six parameters studied (Table 7). The first significant difference is observed in the change in AoBo. In both types of treatment there is a decrease in this indicator, but with a significantly higher value of reduction in the group treated with EF Braces appliance (-2.14 ± 1.61mm) compared to -0.94 ± 2.20mm in the treatment with class II elastics with difference of - 1.20 mm (p = 0.01).

The opposite trend is observed with the change in the effective length of the lower jaw Co-Gn, which in the group with EF Braces appliance increases by + 3.65 ± 3.80 mm, and in the treatment with class II elastics decreases by - 1.85 ± 6.29 mm. The difference in change in the two 5.51 mm treatments was significant and statistically significant (p <0.001). The length of the lower jaw Go-Gn increases in both treatments (+ 2.85 ± 2.67 mm EF Braces appliance - + 0.41 ± 1.26 mm class II elastics), but with a significantly higher value of 2.44 mm in the treatment with EF Braces appliance p <0.001). The upper pharynx showed an increase of + 1.95 ± 2.44 mm in the group treated with the EF Braces appliance, while in class II elastics there was a decrease of -0.09 ± 2.54 mm, with a significant difference of 2.04 mm, p = 0.001.

For the other two linear indicators, the changes occurred did not reach statistical significance. The effective length of the middle front floor Co-A increases by + 0.58 ± 4.09 mm in the treatment with EF Braces appliance and decreases by - 0.51 ± 1.47 mm in the treatment with class II elastics, but the difference of 1.09 mm does not reach statistical significance, p = 0.139.

In both types of treatment there is a minimal increase in the value of the Lower Pharynx (+ 1.01 ± 2.67 mm EF Braces appliance - + 0.01 ± 2.01 mm class II elastics), with a difference of 1 mm, without statistical significance, p = 0.082.

Table 7: Comparison of the change in linear sagittal skeletal parameters in the groups treated with EF Braces and class II elastics

Linear Sagittal Skeletal parameters (mm)	**Treatment**			**t-test**
	EF Braces (N = 35)	Class II elastics (N=35)	95% CI	p
A_oB_o change **X̄ (±SD)**	-2.14 (±1.61)	-0.94 (±2.20)	1.20 -0.27 to -2.12	0.011*
Co-A change **X̄ (±SD)**	+ 0.58(±4.09)	-0.51 (±1.47)	1.09 0.38 to 2.58	0.139
Co-Gn change **X̄ (±SD)**	+3.65 (±3.80)	+0.65 (±2.01)	3.00 1.54 to 4.45	0.000***!
Go-Gn change **X̄ (±SD)**	+2.85 (±2.67)	+0.41 (±1.26)	2.44 1.44 to 3.43	0.000***
Upper pharynx change **X̄ (±SD)**	+1.95 (±2.44)	-0.09 (±2.54)	2.04 0.85 to 3.23	0.001**
Lower pharynx change **X̄ (±SD)**	+1.01 (±2.67)	+0.01 (±2.01)	1.00 0.13 to 2.13	0.082

IV.1.3 Change in angular dental parameters

EF Braces treatment

In the group of patients treated with EF Braces, the dynamics in the angular dental parameters are summarized in Table 8 and described below.

Table 8: Change in angular dental parameters after treatment with the **EF Braces appliance**

Angular dental parameters (°)	**X̄ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
∢I/SpP before treatment	114.71 (±9.37)	-0.66 (±5.24)	-2.45 to 1.14	0.463
∢I/SpP after treatment **(110±5°)**	114.05 (±7.12)			

∢I/Sn before treatment	105.81 (±8.38	- 0.66 (±5.47)	-2.53 to 1.22	0.482
∢I/Sn after treatment (**102°-105°**)	105.15 (±6.75)			
∢I/NA before treatment	25.04 (±5.87)	- 0.81 (±5.48)	-2.69 to 1.07	0.386
∢I/NA after treatment (**22°**)	24.22 (±5.87)			
∢i/MP before treatment	99.07 (±7.75)	+ 2.83 (±2.36)	2.01 to 3.66	0.000***
∢i/MP after treatment (**85° - 95°**)	101.91 (±7.35)			
∢i/NB before treatment	28.39 (±7.73)	+ 2.33 (±3.44)	1.15 to 3.52	0.000***
∢i/NB after treatment (**25°**)	30.72 (±7.12)			

The inclination of the upper incisor relative to the spinal plane ∢I / SpP decreased from 114.71 ± 9.37 ° to 114.05 ± 7.12 °, but the change from -0.66 ° did not reach significance (p = 0.463). The inclination of the upper incisor relative to the base of the skull ∢I / Sn also decreased by -0.66 ° from 105.81 ± 8.38 ° to 105.15 ± 6.75 ° without significance of the change (p = 0.482). A decrease of -0.81 ° (no statistical significance, p = 0.386) occurs in the inclination of the upper incisor relative to the NA - ∢I / NA line from 25.04 ± 5.87 ° to 24.22 ± 5.87 °.

A significant increase is observed in the next two indicators. The inclination of the lower central incisor ∢i / MP increased from 99.07 ± 7.75 ° to 101.91 ± 7.35 °, with a significant change of ± 2.83 ° (p <0.001). A significant increase of + 2.33 ° occurs in the inclination of the lower incisor relative to the line NB - ∢i / NB from 28.39 ± 7.73 ° to 30.72 ± 7.12 °, p <0.001.

Treatment with class II elastics

The dynamics in the angular dental parameters in patients treated with class II elastics are presented in Table 9 with a description of the changes thereafter.

Table 9: Change in angular dental parameters after treatment with **class II elastics**

Angular dental parameters (°)	$\bar{X}$ (±SD)	Change		t-test
		Change	95% ДИ	p
∢I/SpP before treatment	110.97 (±7.25)	-3.06 (±5.93)	-1.01 to -5.09	0.004**
∢I/SpP after treatment **(110±5°)**	107.91 (±8.97)			
∢I/Sn before treatment	103.55 (±10.92)	-1.54 (±6.45)	-3.75 to 0.67	0.166
∢I/Sn after treatment (**102°-105°**)	102.01 (±7.54)			
∢I/NA before treatment	23.51 (±9.20)	-0.91 (±7.19)	-3.38 to 1.55	0.457
∢I/NA after treatment **(22°)**	22.60 (±5.50)			
∢i/MP before treatment	96.62 (±6.48)	+ 4.92 (±4.63)	3.33 to 6.52	0.000***
∢i/MP after treatment (**85° - 95°**)	101.55 (±5.88)			
∢i/NB before treatment	27.23 (±5.18)	+3.65 (±6.46)	1.14 to 6.16	0.006**
∢i/NB after treatment (**25°**)	30.88 (±4.63)			

As a result of treatment with class II elastics, a significant reduction in the inclination of the upper incisor relative to the spinal plane ∢I / SpP was reported, from 110.97 ± 7.25 ° to 107.91 ± 8.97 °, with a change magnitude of -3.06 ° (p <0.001). The inclination of the upper incisor relative to the skull base ∢I / Sn also decreased from 103.55 ± 10.92 ° to 102.01 ± 7.54 ° with a difference of -1.54 °, but without statistical significance (p = 0.166). A decrease of -0.91 ° without statistical significance (p = 0.457) occurs in the inclination of the upper incisor relative to the line NA - ∢I / NA from 23.51 ± 9.20 ° to 22.60 ± 5.50 °.

A significant increase was observed in the inclination of the lower central incisor relative to the mandibular plane ∢i / MP, from 96.62 ± 6.48 ° to 101.55 ± 5.88 ° with a significant change of ± 4.92 ° (p <0.001). The inclination of the lower incisor relative to the NB - ∢i / NB line also increased, from 27.23 ± 2.85 ° to 30.88 ± 5.18 °, with a significant change from + 3.65 ° (p = 0.006).

Comparison of the change in the angular dental parameters during treatment with EF Braces appliance and with class II elastics

The change in angular dental parameters between the two types of treatment (Table 10) does not show significant differences related to the method of treatment. The inclination of the upper incisor ∢I / SpP decreased in both treatments, with a higher change in value of -3.06 ± 5.93 ° in the group treated with class II elastics compared to -0.66 ± 0.54 ° in the treatment with EF Braces, with significant difference of - 2.40 °, which does not reach statistical significance (p = 0.077). It also reduces the inclination of the upper incisor ∢I / Sn in both types of treatment, with a greater value of change of -1.54 ± 6.45 ° in the treatment with class II elastics compared to -0.66 ± 5.47 ° in the treatment with EF Braces with a difference from -0.88 ° (p = 0.538). The inclination of the upper incisor ∢I / NA decreased by -0.81 ± 5.48 ° in the treatment with EF Braces and by -0.91 ± 7.19 ° in the treatment with class II elastics, with a minimum difference of -0.10 °, p = 0.948. The inclination of the lower central incisor ∢i / MP shows a significant increase in both treatment methods, with a higher value of change (+ 4.92 ± 4.63 °) in patients treated with class II elastics compared to EF Braces appliance + 2.83 ± 2.36 °), with a significant difference of + 2.09 °, p = 0.022. The inclination of the lower incisor ∢i / NB increased by + 2.33 ± 3.44 ° in the patients treated with EF Braces appliance and by +3.65 ± 6.46 ° in the patients treated with class II elastics with a difference of 1.32 °, without statistical significance (p = 0.229) .

Table 10: Comparison of the change in angular dental parameters in the groups treated with EF Braces and class II elastics

Angular dental parameters (°)	**Treatment**			**t-test**
	EF Braces appliance (N = 35)	Class II elastics (N=35)	95% CI	p
∢I/SpP change **$\bar{X}$ (±SD)**	-0.66 (±5.24)	-3.06 (±5.93)	2.40 -5.06 to 0.26	0.077
∢I/Sn change **$\bar{X}$ (±SD)**	-0.66(±5.47)	-1.54 (±6.45)	0.88 -1.96 to 3.73	0.538

∢I/NA change **$\bar{X}$ (±SD)**	-0.81 (±5.48)	-0.91(±7.19)	0.10 -3.15 to 2.95	0.948!
∢i/MP change **$\bar{X}$ (±SD)**	+2.83 (±2.36)	+4.92 (±4.63)	2.09 0.31 to 3.86	0.022*!
∢i/NB change **$\bar{X}$ (±SD)**	+2.33 (±3.44)	+3.65 (±6.46)	1.32 -0.84 to 3.47	0.229!

IV.1.4 Change in linear dental parameters

EF Braces treatment

The dynamics in the linear dental parameters I / NA and i / NB during the treatment with EF Braces appliance showed a decrease of I / NA from 4.61 ± 1.57 mm to 4.32 ± 1.45 mm, without significance of the difference of -0.29 mm, p = 0.195. The opposite trend was observed at i / NB, where there was a significant increase of 0.91 mm from 5.22 ± 2.97 mm before treatment to 6.14 ± 2.77 mm after treatment, p <0.001 (Table 11)

Table 11: Change in linear dental parameters after treatment with EF Braces

Linear dental parameters (mm)	**$\bar{X}$ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
I/NA before treatment	4.61 (±1.57)	-0.29 (±1.27)	-0.72 to 0.15	0.195
I/NA after treatment **(4mm)**	4.32 (±1.45)			
i/NB before treatment	5.22 (±2.97)	+0.91 0.000*** (±1.01)	0.56 to 1.26	
i/NB after treatment **(4mm)**	6.14 (±2.77)			

Treatment with class II elastics

In patients treated with class II elastics, similar dynamics were found in the linear dental parameters I / NA and i / NB with that in the treatment with EF Braces appliance (Table 12). The value of I-NA decreased from 5.50 ± 2.90 mm to 4.61 ± 1.63 mm, with a difference of -0.88 mm without statistical significance, p = 0.063. In i-NB there was a significant increase of 1.31 mm, from 5.07 ± 1.94 mm before treatment to 6.45 ± 1.72 mm after treatment, p <0.001.

Table 12: Change in linear dental parameters after treatment with class II elastics

Linear dental parameters (mm)	$\bar{X}$ (±SD)	Change		t-test
		Change	95% CI	p
I/NA before treatment	5.50 (±2.90)	-0.88 (±2.73)	-1.82 to 0.52	0.063
I/NA after treatment **(4mm)**	4.61 (±1.63)			
i/NB before treatment	5.07 (±1.94)	+1.38 0.000*** (±1.98)	0.70 to 2.06	
i/NB after treatment **(4mm)**	6.45 (±1.72)			

Comparison of the change in the linear dental parameters during treatment with EF Braces and class II elastics

The change in the linear dental parameters I / NA and i / NB between the two types of treatment (Table 13) does not show significant differences related to the method of treatment. In both patient groups there was a decrease in I / NA, which is -0.59 mm greater in the treatment with class II elastics (-0.29 ± 1.27 mm) compared to treatment with the EF Braces appliance (-0.88 ± 2.73 mm), but without statistical significance (p = 0.245). In both methods of treatment there was an increase in i / NB, which is + 0.47 mm greater in patients treated with class II elastics (+ 1.38 ± 1.98 mm) compared to EF Braces appliance (+ 0.91 ± 1.01 mm) , but the difference does not reach statistical significance (p = 0.216).

Table 13: Comparison of the change in linear dental parameters in the groups treated with EF Braces and class II elastics

Linear dental parameters (mm)	Treatment			t-test
	EF Braces (N = 35)	Class II elastics (N=35)	Difference 95% CI	p
I/NA change **$\bar{X}$ (±SD)**	-0.29 (±1.27)	-0.88 (±2.73)	0.59 -1.61 to 0.41	0.245!

i/NB change			0.47	
$\bar{X}$ (±SD)	+0.91 (±1.01)	+1.38 (±1.98)	-0.28 to 1.22	0.216!

Discussion on Problem 1

Angular sagittal skeletal parameters

When comparing the results obtained with the two methods of treatment, it is noticed that both modalities successfully correct the skeletal class II malocclusion, as evidenced by the similar reduction and normalization of ∢ANB in both groups. However, there is a significant difference in the causal factor for the improvement of ∢ANB. While in the group treated with class II elastics, it is due to a decrease in ∢SNA, in the group treated with EF Braces appliance, it is mainly due to an increase in ∢SNB. There is a significant difference in the effects of the two modalities on the upper and lower jaw - intermaxillary traction reduces the value of ∢SNA by 1.95° more than EF Braces, and myotrainer increases that of ∢SNB by 1.81° more than class II elastics. The latter mainly affects the maxilla, inhibiting its growth and has no pronounced effect on the mandible.

Linear sagittal skeletal parameters

The comparison between the changes in the linear sagittal skeletal parameters in the groups treated with EF Braces and class II elastics revealed significant differences in 4 of the 6 parameters - AoBo, Co-Gn, Go-Gn and upper pharynx. We attribute the greater increase in AoBo by 1.2 mm in the myotrainer group to the lack of change in the inclination of the occlusal plane (the change in ∢OcP / Sn is + 0.48° without statistical significance). In the group treated with intermaxillary traction, the occlusal plane significantly changed its inclination (+ 1.47 °) and rotated clockwise. A significant increase was observed in the values of Co-Gn and Go-Gn in the group treated with EF Braces, compared to those treated with class II elastics - by 3.00 mm and 2.44 mm, respectively. Increased sagittal growth is due to enchondral ossification induced in condylar cartilage. These results are evidence of the better clinical effect of EF Braces with reduced mandibular size. EF Braces therapy increased the upper pharynx by 1.95 mm, while that of class II elastics reduced it by 0.09 mm, with an average difference in the effect of the two methods of 2.04 mm, which is statistically significant. This result confirms that EF Braces has a positive effect on the development of the pharyngeal space.

Angular sagittal dental parameters

From the comparison of the angular dento-alveolar parameters between the two groups we can observe the following trends: both in class II elastics and EF Braces there is a decrease in inclination of the upper incisors relative to the planes Sn and SpP and the NA line and increase inclination of lower incisors to the mandibular plane and the NB line. These angular changes indicate that the movement of the incisors is a type of inclination, not a bodily movement, as the force is applied far from the centre of resistance. All changes were more pronounced in patients treated with intermaxillary traction, with only a difference in ∢i / MP of 2.09° reaching statistical significance. The difference of 2.40 ° in the inclination of the upper incisors to the Sn plane and the difference of 1.32 ° in the inclination of the lower incisors to the NB line are of clinical significance.

Linear sagittal dental parameters

When comparing the mean values of the change in the linear dentoalveolar parameters in the two groups, no statistical significance was reached.

IV.2 Problem 2: To compare the vertical skeletal cephalometric changes in the two treatment methods

Results of Problem 2

IV.2.1 Change in vertical angular parameters

EF Braces treatment

No significant change in vertical angular parameters was observed in patients treated with the EF Braces appliance (Table 14). The first parameter ∢MP / Sn showed a decrease in degrees from 31.81 ± 7.44 ° to 31.34 ± 6.69 ° with a difference of -0.47 ° without statistical significance ($p = 0.444$). The value of ∢MP / SpP decreases from 22.95 ± 6.46 ° to 22.37 ± 6.01 ° with a difference of - 0.58 ° ($p = 0.201$). The indicator ∢OcP / Sn shows an increase from 13.84 ± 4.69 ° before treatment to 14.32 ± 4.84 ° after treatment with a difference of + 0.48 °, which does not reach statistical significance ($p = 0.350$).

Table 14: Change in vertical angular parameters after treatment with **EF Braces appliance**

Vertical angular parameters (°)	$\bar{X}$ (±SD)	Change		t-test
		change	95% CI	p
MP/Sn before treatment	31.81 (±7.44)	-0.47 (±3.60)	-1.70 to 0.76	0.444
MP/Sn after treatment **(29°-35°)**	31.34 (±6.69)			
MP/SpP before treatment	22.95 (±6.46)	-0.58 (±2.65)	-1.49 to 0.32	0.201
MP/SpP after treatment **(22°-28°)**	22.37 (±6.01)			
OcP/Sn before treatment	13.84 (±4.69)	+0.48 (±3.03)	0.55 to 1.52	0.350
OcP/Sn after treatment **(14°-16°)**	14.32 (±4.82)			

Treatment with class II elastics

In contrast to the treatment with EF Braces appliance, in which the change in the vertical angular parameters did not show statistical significance, in the treatment with class II elastics a significant change was reported in two of them (Table 15). The first parameter ∢MP / Sn slightly increased by + 0.30 °, from 32.88 ± 5.90 ° to 33.18 ± 6.50 °, but without statistical significance (p = 0.499). For the next two parameters, the change showed statistical significance. ∢MP / SpP increased from 26.54 ± 5.80 ° to 27.81 ± 6.43 °, with a significant difference of + 1.27 ° (p = 0.008). The third parameter ∢OcP / Sn showed a significant increase of + 1.47 °, from 15.29 ± 4.68 ° before treatment to 16.75 ± 4.25 ° after treatment (p = 0.013).

Table 15: Change in vertical angular parameters after treatment with **class II elastics**

Vertical angular parameters (°)	$\bar{X}$ (±SD)	Change		t-test
		Change	95% CI	p

MP/Sn before treatment	32.88 (±5.90)	+0.30 (±2.59)	-0.59 to 1.19	0.499
MP/Sn after treatment **(29°-35°)**	33.18 (±6.50)			
MP/SpP before treatment	26.54 (±5.80)	+1.27 (±2.65)	0.35 to 2.18	0.008**
MP/SpP after treatment **(22°-28°)**	27.81 (±6.43)			
OcP/Sn before treatment	15.28 (±4.68)	+1.47 (±3.33)	0.31 to 2.61	0.013*
OcP/Sn after treatment (14°-16°)	16.75 (±4.25)			

Comparison of the change in vertical angular parameters in the groups treated with EF Braces appliance and with class II elastics

The change in vertical angular parameters did not show a significant relationship with the treatment method (Table 16). In patients treated with EF Braces appliance a decrease in ∢MP / Sn by -0.47 ± 3.60 ° was reported, while in treatment with class II elastics there was an increase of + 0.30 ± 2.59 °, but no significance of the difference of 0.77 ° (p = 0.308). ∢MP / SpP decreased by -0.58 ± 2.65 ° in the group treated with the EF Braces appliance and increased by 1.27 ± 2.65º in the treatment with class II elastics, with a significant difference of 1.85 ° (p = 0.005). The third parameter ∢OcP / Sn showed an increase in both treatments, with a greater value of change in the treated with class II elastics (+ 1.47 ± 3.33 °) compared to the group treated with EF Braces appliance (+ 0.48 ± 3.03 °), the difference of 0.98 ° is not statistically significant (p = 0.200).

Table 16: Comparison of the change in vertical angular parameters in the groups treated with EF Braces and Class II elastics

Vertical angular parameters (°)	**Treatment**			**t-test**
	EF Braces (N = 35)	Class II elastics (N=35)	Difference 95% CI	p
MP/Sn change **X̄ (±SD)**	-0.47 (±3.60)	+0.30 (±2.59)	0.77 -0.72 to 2.26	0.308

MP/SpP change **$\bar{X}$ (±SD)**	-0.58 (±2.65)	+1.27 (±2.65)	1.85 0.58 to 3.12	0.005**
OcP/Sn change **$\bar{X}$ (±SD)**	+0.48 (±3.03)	+1.47 (±3.33)	0.98 -0.53 to 2.50	0.200

IV.2.2. Relationship between the change in ∢MP / Sn and the change in ∢OcP / Sn depending on the initial values of ∢MP / Sn

The potential relationship between the change in ∢MP / Sn and the change in ∢OcP / Sn depending on initial values of ∢MP / Sn, according to which patients were categorized into three groups: ∢Mn / Sn before treatment <30º; ∢Mn / Sn before treatment 30º to 34º; ∢Mn / Sn before treatment> 34º was analyzed by Spearman rank-order correlation.

Analysis of the relationship between the change in ∢Mn / Sn and the initial values of ∢Mn / Sn

During treatment with the EF Braces appliance, a significant relationship was found between the change in the vertical angular parameter ∢Mn / Sn and the values of ∢Mn / Sn before treatment (Fig. 5). The association is of medium value, with the opposite direction **(r^s = -0.454, p = 0.006).** An increase in ∢Mn / Sn values was observed in patients with initial Mn / Sn values <30º. It can be seen that in this group of patients the mean change is positive **+ 1.17 ± 3.62º**, while in the other two categories, the change is negative, corresponding to a decrease in the degrees of ∢Mn / Sn after treatment, specifically **-2.0 ± 3.89 º** in patients in the category ∢Mn / Sn 30º to 34º and **-2.05 ± 2.43º** in patients in the category ∢Mn / Sn> 34º.

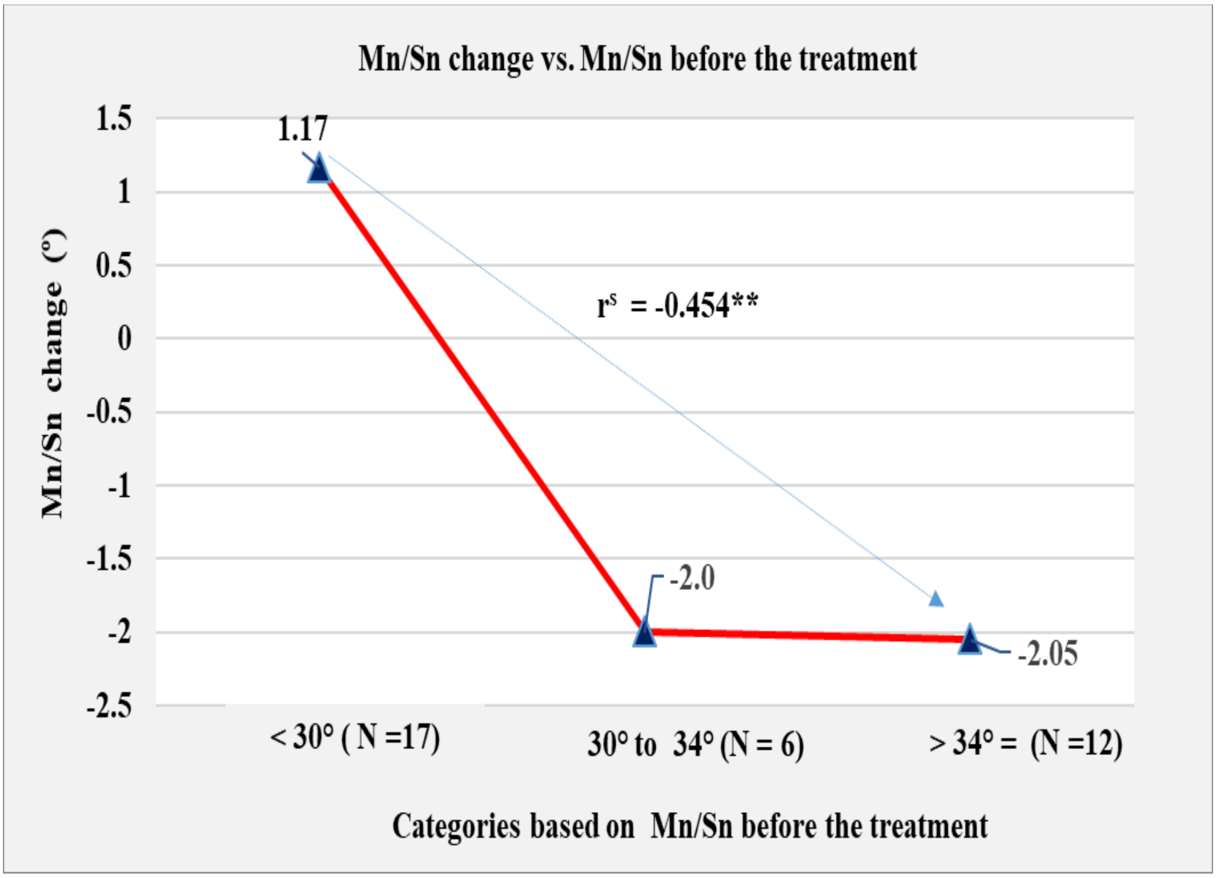

FIG. 5: Inverse association between the change in ∢Mn / Sn and the initial values of ∢Mn / Sn during treatment with the **EF Braces appliance**

During treatment with class II elastics, no significant association was found between the change in ∢Mn / Sn and initial values of ∢Mn / Sn before treatment (**r^s = -0.078, p = 0.658**). In patients in the ∢Mn / Sn category <30º the mean change in ∢Mn / Sn was + **0.43** ± **2.89º**; in the category ∢Mn / Sn between 30º and 34º the change in ∢Mn / Sn has an average value of **+ 0.50** ± **3.11º**; in the category ∢Mn / Sn> 34º the change has a negative sign (decrease) but with a low value **-0.04** ± **1.73º**.

Analysis of the relationship between the change in ∢OcP / Sn and the initial values of ∢Mn / Sn

During treatment with the EF Braces appliance, the values of the change in OcP / Sn change from the initial values of Mn / Sn as follows: + **0.92** ± **2.87º** in the group Mn / Sn <30º; + **0.50** ± **3.56º** at Mn / Sn 30 º to 34 º; **-0.12** ± **3.03º** at Mn / Sn> 34 º. There is a certain inverse association that does not reach statistical significance (**r^s = -0.155, p = 0.374)** (Fig. 6).

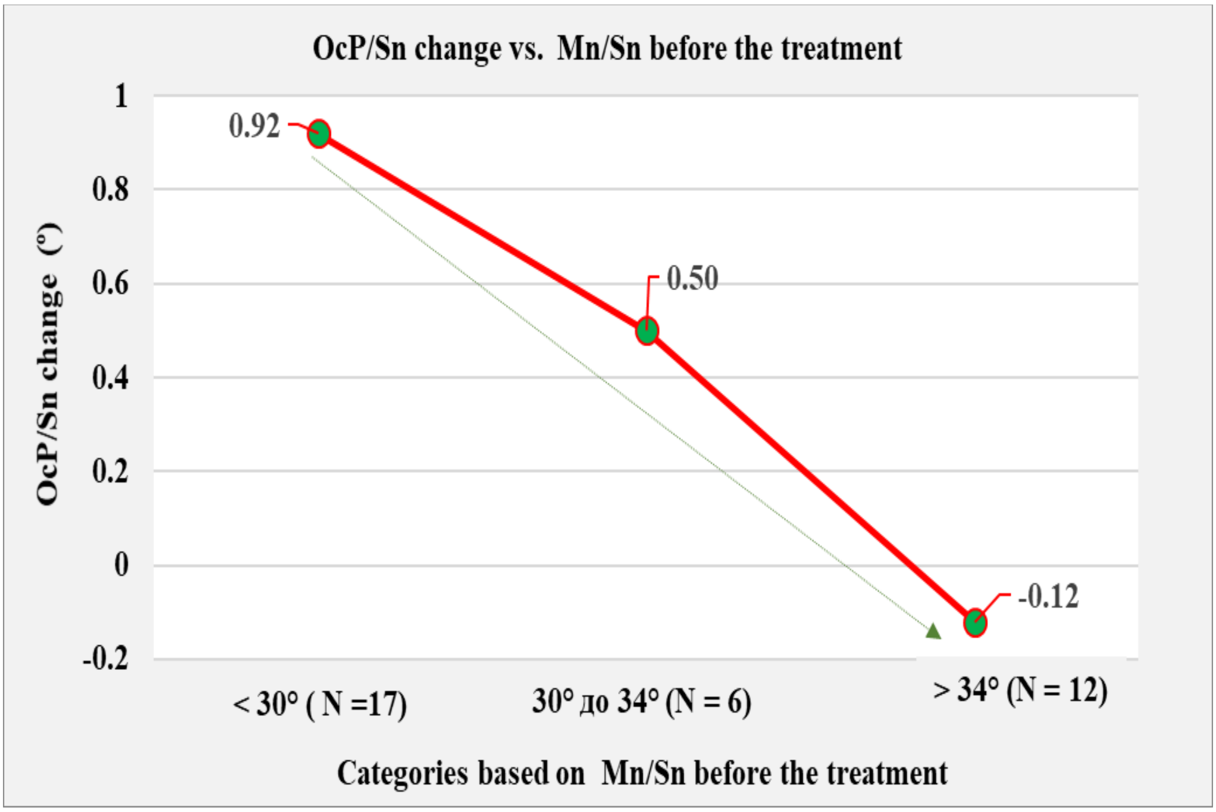

Fig. 6: The change in ∢OcP / Sn relative to initial ∢Mn / Sn values during treatment with the **EF Braces appliance**. An inverse association is emerging, but without statistical significance.

In the treatment with class II elastics, the values of the change in ∢OcP / Sn are positive in the three categories of patients compared to the initial value of ∢Mn / Sn, but a certain inverse association is observed, in which the greatest increase in ∢OcP / Sn from + **2.37** ± **2.55°** is found in patients in the category ∢Mn / Sn <30°, followed by the category ∢Mn / Sn 30° to 34° with an increase in ∢OcP / Sn by **1.46** ± **3.13°** and the lowest value of the increase **0.87** ± **4.07 °** for category ∢Mn / Sn> 34°. The correlation coefficient is low and without statistical significance, $\mathbf{r^s = -0.225, p = 0.193}$ (Fig. 7).

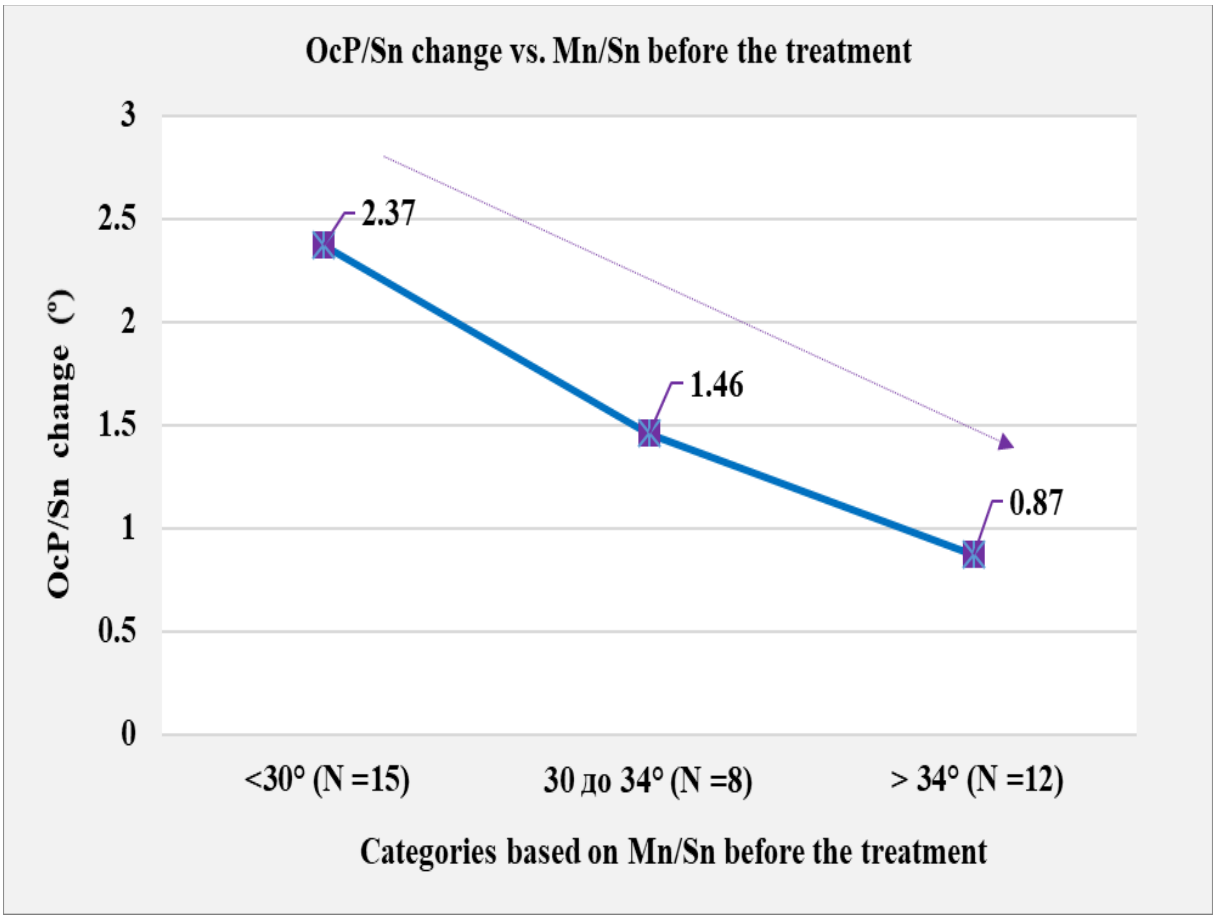

FIG. 7: The change in ∢OcP / Sn relative to initial ∢Mn / Sn values during treatment with **class II elastics**. An inverse association is emerging, but without statistical significance.

IV.2.3. Change in vertical linear parameters and ratios

EF Braces treatment

After treatment with the EF Braces appliance, a significant change was found in the two vertical linear parameters (Table 17). In the first parameter N: Me there is a significant increase of 3.55 mm, from 111.43 ± 8.30 to 114.98 ± 8.25 mm, p = 0.001. The second parameter S: Go also increased significantly by 2.85 mm, from 78.10 ± 10.22 mm to 80.95 ± 8.93 mm, p = 0.001. The S: Go / N: Me ratio decreased minimally by -0.03% from 69.85 ± 6.34% to 69.82 ± 7.06% with no statistical significance of the difference, p = 0.976.

Table 17: Change in vertical linear parameters and ratios after treatment of class II 1 malocclusion with **EF Braces appliance**

Vertical linear parameters	**X̄ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
N:Me before treatment **(mm)**	111.43 (±8.30)	+3.55 (±5.59)	+1.19 to 4.51	0.001**
N:Me after treatment (mm)	114.98 (±8.25)			
S:Go before treatment **(mm)**	78.10 (±10.22)	+2.85 (±4.82)	+1.63 to 5.47	0.001**
S:Go after treatment (mm)	80.95 (±8.93)			
S:Go/N:Me before treatment **(%)**	69.85 (±6.34)	-0.03 (±5.57)	-1.94 to 1.88	0.976
S:Go/N:Me after treatment **(%)**	69.82 (±7.06)			

Treatment with class II elastics

In patients treated with class II elastics, a significant change was found in the last two of the vertical linear parameters and ratios (Table 18). In the first parameter N: Me there is an increase of 0.11 mm, from 115.17 ± 6.51 mm to 115.28 ± 6.69 mm, without significance of the change (p = 0.773). The second parameter S: Go decreased significantly by -1.03 mm, from 78.51 ± 7.85 mm to 77.48 ± 8.01 mm (p = 0.00) 4. Significant reduction was also found in the S: Go / N: Me ratio, from 68.14 ± 5.17% to 67.25 ± 5.33%, with a significant difference of -0.89%, p = 0.009.

Table 18: Change in vertical linear parameters and ratios after treatment with **class II elastics**

Vertical linear parameters	**X̄ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
N:Me before treatment **(mm)**	115.17 (±6.51)	+0.11 (±2.32)	-0.68 to 0.91	0.773
N:Me after treatment (mm)	115.28 (±6.69)			
S:Go before treatment **(mm)**	78.51 (±7.85)	-1.03 (±1.96)	-0.35 to - 1.70	0.004**
S:Go after treatment (mm)	77.48 (±8.01)			

S:Go/N:Me before treatment (%)	68.14 (±5.17)	-0.89 (±1.89)	-0.23 to -1.53	0.009**
S:Go/N:Me after treatment (%)	67.25 (±5.33)			

Comparison of the change in vertical linear parameters and ratios in the groups treated with EF Braces and Class II elastics

The change in vertical linear parameters and ratios showed a significant relationship with the treatment method in two of the three parameters studied (Table 19). The first significant difference relates to the change in N: Me values, which showed an increase in both treatment methods, but with a significantly greater change in treatment with EF Braces appliance +3.55 ± 5.59mm compared to + 0.11 ± 2.32mm in the treatment with class II elastics with a significant difference of + 3.44mm, p = 0.001. The second significant difference was found in the change in S: Go, which showed an increase of + 2.85 ± 4.82 mm in the treatment with EF Braces appliance and a decrease of -1.03 ± 1.96 mm in patients treated with class II elastics. The difference between the two methods of 3.88 mm showed high statistical significance, p <0.001.

The S: Go / N: Me ratio decreases with both methods of treatment - 0.03 ± 5.57% EF Braces appliance; 0.89 ± 1.89% class II elastics with a difference of 0.86% without statistical significance p = 0.364.

Table 19: Comparison of the change in vertical linear parameters and ratios in the groups treated with EF Braces and Class II elastics

Vertical linear parameters	**Treatment**			**t-test**
	EF Braces (N = 35)	Class II elastics (N=35)	95% CI	p
N:Me change **$\bar{X}$ (±SD) (mm)**	+3.55 (±5.59)	+0.11 (±2.32)	3.44 1.39 to 5.48	0.001**!
S:Go change **$\bar{X}$ (±SD) (mm)**	+2.85 (±4.82)	-1.03 (±1.96)	3.88 2.12 to 5.64	0.000***!
S:Go/N:Me cahnge **$\bar{X}$ (±SD) (%)**	-0.03 (±5.57)	-0.89 (±1.89)	0.86 -0.99 to-2.90	0.364!

<u>Discussion on Task 2</u>

<u>Angular vertical parameters</u>

In the comparison between the mean results obtained after treatment with class II elastics and EF Braces, there was a statistically significant difference only in the change in the inclination of the mandibular plane compared to the spinal, which is 1.85 greater in the intermaxillary traction group. When comparing the results of the other parameters, a greater increase in the values in the group treated with class II elastics was also observed. This clearly shows that Class II elastics are only suitable for use in hypo- and norm-divergent growth types because they cause posterior rotation of the lower jaw. The division of patients by type of growth in both groups and the research on the change in ∢MP / SN and ∢OcP / Sn depending on it confirms this conclusion. In hyperdivergent patients, it is more appropriate to use EF Braces because of its myofunctional effect, which inhibits the excessive vertical growth. Myotrainer can be successfully applied in hypo- and normodivergent types, respectively normalizing and preserving the type of growth.

<u>Linear vertical indicators and ratios</u>

When comparing the effects in the linear vertical parameters after the two methods of treatment, a significant difference in the changes in both the anterior and posterior facial height is observed. The EF Braces appliance significantly increases N: Me by 3.44 mm more than that of class II elastics. S: Go decreases due to the intermaxillary traction and increases as a result of myotrainer application by 3.88 mm. These results indicate that growth in the vertical direction is stimulated to a much greater extent as a result of the application of EF Braces.

IV.3. Task 3: To determine the changes in the transverse dimensions of the upper and lower dental arches on orthodontic models in the studied treatment modalities.

<u>Results of Problem 3</u>

EF Braces treatment

No significant change in transverse size was observed in patients treated with the EF Braces appliance in the upper jaw (Table 20). At the intercanine distance C-C, an increase of 0.19 mm was observed from 25.83 ± 1.95 mm before treatment to 26.02 ± 1.91 mm after treatment (p = 0.207). The interpremolar distance P-P increased by 0.26 mm from 37.85 ± 2.83 mm before treatment to 38.11 ± 2.59 mm after treatment (p = 0.207). No change was observed in the intermolar distance M-M, which maintained the pre-treatment mean value(45.95 ± 3.00 mm), p = 0.207.

In the lower jaw, all three measurements show a significant change. The intercanine distance C-C increased by 0.60 mm, from 20.29 ± 1.81 mm before treatment to 20.89 ± 1.81 mm after treatment (p <0.001). A significant increase of 0.79 mm (p <0.001) was observed at the interpremolar distance P-P of 37.55 ± 2.48 mm before treatment to 38.28 ± 2.40 mm after treatment. The intermolar distance M-M increased by 0.60 mm, from 47.38 ± 3.03 mm before treatment to 47.98 ± 3.04 mm after treatment (p <0.001).

Table 20: Transverse dimensional change after treatment with the **EF Braces appliance**

Transverse parameters (мм)	$\bar{X}$ **(±SD)**	**Change**		**t-test**
		Change	95% CI	p
		Upper jaw		
C-C before treatment	25.83 (±1.95)	+0.19 (±0.86)	-0.10 to 0.48	0.207
C-C after treatment	26.02 (±1.91)			
P-P before treatment	37.85 (±2.83)	+0.26 (±0.86)	-0.03 to 0.55	0.083
P-P after treatment	38.11 (2.59)			
M-M before treatment	45.95 (±3.00)	0.00 (±1.19)	-0.41 to 0.41	1.000
M-M after treatment	45.95 (±2.79)			
		Lower jaw		
C-C before treatment	20.29 (±1.81)	+0.60 0.000*** (±0.74)	0.34 to 0.85	
C-C after treatment	20.89 (±1.81)			
P-P before treatment	37.55 (±2.48)			

P-P after treatment	38.28 (±2.40)	+ 0.73 0.000*** (±0.96)	0.40 to 1.06
M-M before treatment	47.38 (3.03)	+0.60 0.000*** (±0.75)	0.34 to 0.86
M-M after treatment	47.98 (±3.04)		

Treatment with class II elastics

In patients treated with class II elastics, the transverse dimensions in the upper jaw showed a significant change in the intercanine distance C-C (Table 21). From 25.48 ± 2.74 mm before treatment C-C decreased to 25.20 ± 2.76 mm after treatment, with a significant difference of - 0.28 mm (p = 0.014). The interpremolar distance P-P increased by 0.03 mm from 37.31 ± 2.03 mm before treatment to 37.34 ± 2.04 mm after treatment without significant change (p = 0.226). The change in intermolar distance M-M showed a minimal increase of 0.05 mm from 44.89 ± 2.78 mm before treatment to 44.94 ± 2.68 mm after treatment, p = 0.733.

In the lower jaw, a significant change was observed only with respect to the intermolar distance M-M, which decreased by -0.76 mm from 47.40 ± 3.44 mm before treatment to 46.64 ± 3.06 mm after treatment (p <0.001). In the other two studied parameters the change does not reach statistical significance. The intercanine distance C-C increased by 0.03 mm, from 20.32 ± 1.48 mm before treatment to 20.35 ± 1.47 mm after treatment (p = 0.264). The interpremolar distance P-P decreased by -0.04 mm from 37.52 ± 2.20 mm before treatment to 37.48 ± 2.19 mm after treatment without significant change, p = 0.341.

Table 21: Change in transverse dimensions after treatment with **class II elastics**

Transverse parameters	**$\bar{X}$ (±SD)**	**Change**		**t-test**
		Change	95% CI	p
Upper Jaw				
C-C before treatment	25.48 (±2.74)	-0.28 (±0.63)	-0.06 до -0.49	0.014*
C-C after treatment	25.20 (±2.76)			
P-P before treatment	37.31 (±2.03)	+0.03 (±0.16)	-0.22 до 0.09	0.226
P-P after treatment	37.34 (±2.04)			

M-M before treatment	44.89 (±2.78)	+0.05 (±0.73)	-0.21 до 0.29	0.733
M-M after treatment	44.94 (±2.68)			
Lower Jaw				
C-C before treatment	20.32 (±1.48)	+0.03 (±0.11)	-0.01 до 0.06	0.264
C-C after treatment	20.35 (±1.47)			
P-P before treatment	37.52 (±2.20)	-0.04 (±0.20)	-0.10 до 0.4	0.341
P-P after treatment	37.48 (±2.19)			
M-M before treatment	47.40 (±3.44)	-0.76 (±1.16)	-0.36 до – 1.15	0.000***
M-M after treatment	46.64 (±3.06)			

Comparison of the change in the transverse dimensions in the upper and lower jaw in the groups treated with EF Braces and class II elastics

The change in the intercanine distance C-C shows the opposite direction in both methods of treatment. In the EF Braces appliance an increase of + 0.19 ± 0.86 mm was reported, while in the treatment with class II elastics there was a decrease of -0.28 ± 0.63 with a significant difference of 0.47 mm, p = 0.012 (Table 22).

The interpremolar distance P-P increased in both treatment methods by +0.26 ± 0.86 mm in the EF Braces appliance and by 0.03 ± 0.16 mm in the treatment with class II elastics, with no significant difference of 0.23 mm (p = 0.137). No change in intermolar distance M-M was observed during treatment with the EF Braces appliance, and a minimal increase of 0.05 ± 0.73 mm occurred during treatment with class II elastics, with no significant difference between the two methods, p = 0.510.

In the lower jaw, the change in all transverse dimensions showed a significant relationship with the method of treatment. In the intercanine distance C-C, an increase was found in both methods of treatment. With EF Braces appliance an increase of +0.60 ± 0.75 mm is reported, and with class II elastics with + 0.03 ± 0.11 mm with a significant difference of 0.57 mm, p <0.001. The interpremolar distance P-P increased in the treatment with EF Braces appliance by + 0.73 ± 0.96 mm and decreased by -0.04 ± 0.20 mm in the treatment with class II elastics, with a significant difference of 0.77 mm, p <0.001.

The biggest difference between the two methods was found in the change in the intermolar distance M-M. In the treatment with EF Braces appliance an increase of + 0.60 ± 0.75 mm was reported, while in the treatment with class II elastics a decrease of -0.76 ± 1.16 was observed with a significant difference of 1.36 mm, p <0.001.

Table 22: Comparison of the change in transverse dimensions after treatment in the groups treated with EF Braces and class II elastics

Transverse dimensions	**Treatment**			**t-test**
	EF Braces (N = 35)	Class II elastics (N=35)	95% CI	p
Upper jaw				
C -C change **X̄ (±SD) (мм)**	+0.19 (±0.86)	-0.28 (±0.63)	0.47 0.10 to 0.82	0.012*
P -P change **X̄ (±SD) (мм)**	+0.26 (±0.86)	+0.03 (±0.16)	0.23 -0.52 to 0.07	0.137!
M -M change **X̄ (±SD) (%)**	0.00 (±1.19)	+0.05 (±0.73)	0.05 -0.43 to -2.90	0.510
Lower jaw				
C-C change **X̄ (±SD) (мм)**	+0.60 (±0.75)	+0.03 (±0.11)	0.57 0.12 to 0.82	0.000***!
P-P change **X̄ (±SD) (мм)**	+0.73 (±0.96)	-0.04 (±0.20)	0.77 0.16 to 1.10	0.000***!
M-M change **X̄ (±SD) (%)**	+0.60 (±0.75)	-0.76 (±1.16)	1.36 0.89 to 1.83	0.000***

Discussion on Problem 3

Comparing the transverse effects after treatment with class II elastics and EF Braces, a significant difference of 0.47 mm in the intercanine distance in the upper jaw, 0.57 mm in the intercanine distance, 0.77 mm in the interpremolar and 1.36 mm in the intermolar distance in the lower jaw. These values indicate that if a slight expansion of the dental arches is needed to compensate for the probable relapse after the end of orthodontic treatment, it is better to use EF Braces myotrainer. Prolonged use of class II elastics is not appropriate, as they incline the lower first molar lingually and, after correcting the sagittal discrepancy in this region, there is a risk of a cusp-to-cusp bite.

IV.4 Task 4: To create a model for predicting the duration of treatment and the expected changes according to the skeletal age and the vertical type of growth when using myofunctional appliances

Results of Problem 4

IV.4.1 Growth stage

The results of the comparison of the mean values of the change in the angular parameters SNB and ANB, the length of the lower jaw Go-Gn and the duration of treatment are summarized in Table 23. Overall, patients in stage 4 growth showed significant differences from the other two stages of growth.

One of the significant differences relates to the duration of treatment, which has the lowest value in patients in stage 4 growth (11.15 ± 3.71 months) compared to stage 3 (13.67 ± 2.44 months) and stage 5. (15.36 ± 4.17 months), p = 0.025. Also in the 4th stage there was a significantly higher value of the increase of the angular parameter SNB by 3.19 ± 0.87 ° compared to 2.27 ± 1.27 ° in the 3rd stage and 1.86 ± 1.38 ° in the 5th stage, p = 0.028. In patients at 4^{th} CVM stage, the greatest value of the decrease in the angular parameter of ANB was - 3.65 ± 1.10 ° compared to -2.22 ± 1.32 ° in stage 3 and -2.18 ± 1.34 ° in the 5th stage, p = 0.01. The change in mandibular length Go-Gn did not show a significant association with growth stage, p = 0.315.

Table 23: Duration of treatment, values of the change in the angular parameters SNB and ANB and the length of the lower jaw Go-Gn according to the stage of growth

Parameters	**Stage of growth**	**$\bar{X}$**	**SD**	**95% Confidence Interval**		**ANOVA p**
				Lower limit	Upper limit	
Treatment duration(months)	3rd	13.67	2.44	11.78	15.55	
	4th	**11.15***	3.71	8.91	13.40	0.025*
	5th	15.36	4.17	12.56	18.17	
SNB change (°)	3rd	2.27	1.27	1.29	3.25	
	4th	**3.19***	0.87	2.61	3.72	0.028*
	5th	1.86	1.38	0.93	2.79	

ANB change (°)	3rd	-2.22	1.32	-1.20	-3.24	
	4th	**-3.65***	1.10	-2.98	-4.32	0.010*
	5th	-2.18	1.34	-1.27	-3.08	
Go-Gn change (mm)	3rd	3.66	2.29	1.90	5.42	
	4th	2.61	2.93	0.84	3.09	0.315
	5th	2.00	1.67	0.87	3.12	

Values with a significant association with the growth stage were further investigated by ROC curve analysis. The purpose of the analysis is to test the ability to predict the results of treatment with the EF Braces appliance by establishing criteria that distinguish patients in 4^{th} CVM stage.

Regarding the prognostic role of growth stage for the duration of treatment, an area under the curve AUC = 0.781 was found with statistical significance (p = 0.003). This means that patients in 4 CVM stage can be distinguished from other stages with 78% accuracy based on the duration of treatment.

As it became clear from the one-factor variation analysis (Table 23), these patients stand out with a significantly shorter treatment period than the other stages. According to the ROK curve analysis, the criterion value characteristic of patients in stage 4 shows a duration of treatment of no more than 11 months to achieve the intended changes. We have seen that the average duration of treatment in the specific group of patients in stage 4 growth is 11.15 months, but for other samples it may vary according to a 95% confidence interval between 8.91 months to 13.40 months.

The criterion value indicates that an increase in SNB greater than 2.6 ° can be predicted in patients with stage 4 growth. According to the one-way variation analysis (Table 23), the mean increase in SNB in individual patients in stage 4 was 3.19 °, and a 95% confidence range indicated that in other samples the change in SNB could vary between 2.61 ° to 3.72 °.

The highest reliability of the prognostic role at the growth stage was found in the change in the angular parameter ANB with area under the curve AUC = 0.813, p <0.001. According to the criterion value, in 4^{th} CVM stage patients, a decrease in ANB with a value greater than - 2.98 ° can be predicted. In Table 23, the mean reduction in ANB in 4^{th} CVM stage patients was -3.65 °. According to the 95% confidence range in other patient groups in stage 4, the decrease in ANB may vary between -2.98 ° to -4.32 °.

IV.4.2 Type of growth

The relationship between the type of growth, the duration of treatment, the change in the angular parameters of SNB and ANB and the length of the lower jaw Go-Gn was studied in a similar way as the stage of growth. The results (Table 24) of the one-factor variation analysis did not show a significant relationship between growth type and target indicators, including treatment duration (p = 0.958), change in SNB (p = 0.319), change in ANB (p = 0.339) and the change in the length of the lower jaw Go-Gn (p = 0.645). However, we can note that the lowest values of change are observed in patients in the category ∢MP / Sn <30°.

Table 24: Duration of treatment, values of the change in the angular parameters SNB and ANB and the length of the lower jaw Go-Gn according to the type of growth

Parameters	**Type of growth Mp/Sn**	**$\bar{X}$**	**SD**	**95% Confidence Interval**		**ANOVA p**
				Lower limit	Upper limit	
Treatment duration(months)	<30	13.35	5.074	10.74	15.96	
	30-34	13.83	5.672	7.88	19.79	0.958
	> 34	13.17	2.823	11.37	14.96	
SNB change (°)	<30	**1.73**	1.37	1.03	2.44	
	30-34	2.33	1.21	1.06	3.60	0.319
	> 34	2.50	1.46	1.57	3.42	
ANB change (°)	<30	**-1.91**	1.24	-2.54	-1.27	
	30-34	-2.66	.81	-3.52	-1.80	0.339
	> 34	-2.41	1.3	-3.24	-1.58	
Go-Gn change (mm)	<30	**2.41**	2.87	.93	3.8	
	30-34	3.25	2.27	.86	5.63	0.645
	> 34	3.29	2.66	1.59	4.9	

IV.4.3 Summary of prognostic trends for EF Braces treatment

Our results determine the **growth stage** as an indicator with a prognostic role in the treatment with EF Braces appliance regarding the duration of treatment and the change in the angular parameters of SNB and ANB. In Table 25 we have summarized the main trends that can be used as guidelines in orthodontic practice.

Table 25: Basic prognoses for EF Braces treatment

Treatment duration	SNB change	ANB change
The desired changes can be achieved within 11 months in patients in CVM 4.	The highest value of increase is predicted in patients in stage 4 growth with values of SNB change> 2.6 °.	The highest value of reduction is predicted in patients in stage 4 growth with values of change in ANB> - 2.9 °.
This period may vary between ≈ 9 and 13 months in different patients in CVM 4 .	The change may vary between 2.61 ° and 3.72 ° in different patients in stage 4 growth.	The change can vary between - 2.98 ° and - 4.32 ° in different patients in the 4th stage of growth.
In patients in stage 3, treatment is expected to last longer with an upper limit of ≈16 months.	In stage 3, an increase in SNB in the range between 1.29 ° and 3.25 ° is predicted.	In stage 3, a decrease in ANB is predicted in the range between - 1.20 ° and -3.24 °.
In patients in CVM 5 an even longer period is predicted, reaching ≈ 18 months.	In a 5-stage, increase of the values between 0.93 ° and 2.79 ° can be expected.	In stage 5, the reduction in ANB is predicted to be in the range of -1.27 ° and -3.08 ° in different patients.

Discussion on Problem 4

The results of our study correlate with those available in the literature on the appropriate treatment time and prove them in regards to myofunctional appliances (EF Braces). They also outline the limits of expected changes depending on the stage of growth. We found that with statistical reliability we can say that class II malocclusion can be corrected at a skeletal level by medialization of the lower jaw, using the EF Braces appliance in CS4, for an average of 11 months with 12 hours of wearing the appliance. This stage differs significantly from the others with a shorter duration of treatment - in CS3 it takes an average of 13 months, and in CS5 - an average of 15 months. 11 months is only a part of the long-term orthodontic treatment, which can take several years in growing patients.

The mean values of increase in ∢SNB and decrease in ∢ANB in stages 3, 4 and 5 found by us give the clinician a good idea of the severity of the cases for which he can apply EF Braces according to the stage of growth. In the 4th stage these are respectively change in ∢SNB + 3.19°, and change in ∢ANB - 3.65°. For the 3rd and 5th stages the values for the same parameters are about 2-2.5°. This indicates that more severe cases of class II malocclusion are recommended to be treated at the peak of growth in view of the shorter duration of treatment. In order to achieve the same results in the 3rd and 5th stages, a longer time of wearing the appliance is needed, which will be reflected in the manifestation of greater dento-alveolar effects, which are not always sought.

It is known that the type of vertical growth affects the severity and approach to the treatment of sagittal discrepancies. We found no statistical significance between vertical growth and duration of treatment, change in ∢ANB, ∢SNB and Go-Gn. In some of the parameters, however, there was a tendency for the least change in hypodivergent patients.

V. CONCLUSIONS

The aim of the dissertation to compare the therapeutic effects of class II elastics and EF Braces myotrainer in the correction of class II 1 malocclusion was fulfilled and based on the documented results the following conclusions can be drawn:

Conclusions on problem 1:

1. Class II elastics shall correct class II malocclusion mainly at the expense of changes in the upper jaw, recorded by reducing the ∢SNA by an average of 1.95°. EF Braces myotrainer achieves the same result, but by medializing the lower jaw - ∢SNB increases by an average of 2.10°.
2. Comparing the effects of the two methods on the size of the jaws, the following results emerged:
    - Class II intermaxillary traction reduces the length of the middle facial floor by 0.51 mm, while with EF Braces it increases by 0.58 mm. Therefore, class II elastics slightly inhibit the growth of the upper jaw.
    - Significant differences in the increase in the effective length of the lower jaw Co-Gn by 3.00 mm and the length of the body of the lower jaw Go-Gn by 3.44 mm illustrate a pronounced stimulating effect on sagittal growth of the mandible due to EF Braces.
3. EF Braces treatment increases the sagittal dimensions of the upper and lower pharynx by 1.95 mm and 1.00 mm, respectively, while class II elastics have virtually no effect on them.
4. Despite the use of the two modalities on thick stainless steel archwires, the following dento-alveolar effects were reported:
    - Class II elastics reduce the inclination of the upper incisors relative to the spinal plane by 2.40 ° more than EF Braces, which, although not statistically significant, is of clinical importance. Other studied parameters illustrating the sagittal position of the upper incisors (∢I / Sn, angular and metric I / NA) reflect the same trend with lower values of the difference.

- The inclination of the lower incisors increases significantly as a result of both methods of treatment. The difference in change values was 1.32 ° and 0.47 mm larger than the NB section and significantly larger by 2.09 ° compared to the mandibular plane as a result of treatment with class II elastics.

5. Both treatments have dento-alveolar and skeletal effects, but dento-alveolar effects are more pronounced in the group treated with intermaxillary traction, while skeletal methods are more pronounced in the group treated with EF Braces.

<u>Conclusions on problem 2:</u>

1. EF Braces affects facial height in a differentiated way depending on the type of vertical growth. In hypodivergent patients, the inclination of the mandibular plane increased relative to the base of the skull by an average of 1.17°, while in hyperdivergent patients it decreased by an average of 2.05°. A similar trend is observed in the inclination of the occlusal plane, but it does not reach statistical significance, as the curve of Spee is pre-straightened with the help of the fixed technique.
2. In the class II elastics group, the occlusal plane is rotated clockwise - ∢OcP / Sn increases significantly by 1.47°.
3. EF Braces myotrainer increases both anterior and posterior facial height synchronously, thus maintaining facial proportions. Class II elastics reduce the posterior facial height by 1.03 mm, which is reflected in a reduction in the index of Jaraback.

<u>Conclusions on problem 3:</u>

1. As a result of the treatment with class II elastics, a statistically significant decrease was observed in the intercanine distance in the upper jaw by 0.28 mm and in the intermolar distance in the lower jaw by 0.76 mm. The other parameters practically do not change.
2. The EF Braces appliance causes a slight expansion in all studied transverse parameters (CC, PP and MM) with the exception of MM in the upper jaw,

which does not change. Larger values of change are reported in the lower jaw.

Conclusions on problem 4:

1. We found that the most appropriate period for the application of EF Braces is CVM4, because then the most pronounced skeletal changes are observed for the shortest period of treatment.
2. The prognostic values of change of ∢ANB, ∢SNB and Go-Gn depending on the vertical type of growth are described, with the slightest effect observed in hypodivergent patients. Therefore, a longer treatment period needs to be predicted for them to achieve the desired results.

VI. INFERENCES

The following inferences can be drawn from the set aim and problems in the dissertation:

1. Treatment of class II malocclusion with both class II elastics and EF Braces appliance is effective in adolescent patients, but the two therapeutic modalities have different indications.

   1. 1. The use of Class II elastics is recommended for overdeveloped upper jaw, as they have a restraining effect on its growth.

   1. 2. Treatment with EF Braces is recommended for retrognathia due to the more pronounced stimulating effect on sagittal growth of the lower jaw, as the myotrainer corrects sagittal relationships by improving the position and size of the lower jaw.

   1. 3. Both methods lead to protrusion of the lower front teeth and retrusion of the upper front teeth, but these effects are more pronounced in patients treated with class II elastics.

2. EF Braces allows, to a greater extent than class II elastics, the expression of the natural sagittal growth of the upper and lower pharynx, which is associated with improved respiratory function.

3. Treatment with class II elastics causes the occlusal plane to rotate clockwise, which is unfavorable in the presence of a gingival smile and hyperdivergent type of growth.

4. EF Braces myotrainer therapy promotes the normalization of vertical growth in both hypodivergent and hyperdivergent patients within the established limits.

5. Treatment with EF Braces causes a slight transverse expansion, despite concomitant treatment with fixed technique, more pronounced in the lower jaw. Class II elastics compress the dental arch in the area of the canines in the upper jaw and the first molars in the lower jaw.

6. The most appropriate period for the use of EF Braces was determined in terms of duration of treatment and desired skeletal effects. As with other functional appliances, this is the pubertal peak of growth, which corresponds to

the 4th CVM period according to the Baccetti method. The effect is also reported for the other stages but it is more slight and takes a longer time.

VII. CONTRIBUTIONS

1. For the first time in Bulgaria an in-depth study was conducted on the changes induced by EF Braces myotrainer.

2. For the first time in Bulgaria the skeletal and dento-alveolar transverse, sagittal and vertical effects of the application of class II elastics have been studied.

3. The skeletal and dento-alveolar transverse, sagittal and vertical effects of the EF Braces appliance were studied.

4. The therapeutic effects of Class II elastics and EF Braces myotrainer in the three planes were compared.

5. Clear guidelines are given for choosing the application of the studied two treatment modalities depending on the desired clinical effect.

6. The average duration of sagittal treatment with the EF Braces appliance depending on the stage of skeletal maturation and the type of vertical growth was determined.

7. The average range of expected changes in the parameters ANB, SNB and Go-Gn depending on the stage of skeletal maturation and the type of vertical growth was determined.

VIII. List of publications related to the dissertation

Articles:

1. Георгиев К., Кръстева С. Приложение на клас II интермаксиларни ластици за корекция на дистална оклузия, Ортодонтски преглед. 2020; 22(1):50-54.
2. Георгиев К, Кръстева С. Лечение на клас II малоклузия с миофункционални апарати: принципи и клинични ефекти, Ортодонтски преглед. 2020; 22(2): 35-41.
3. Georgiev K., S. Krasteva, St. Krasteva. Comparison of the transverse effects of class II elastics and myofunctional appliances during the treatment of class II 1 malocclusion, Suppl J of IMAB. 2021;27:37-39.

Participation in national and international forums:

1. Георгиев К., С. Кръстева, К. Тодорова-Плачийска, М. Калайджиева, М. Стоилова-Тодорова. Сравнителна оценка от ефекта на приложението на клас II интермаксиларно теглене и EF Braces тренер при лечението на клас II 1 малоклузия. Научна конференция по случай 75-годишния юбилей на МУ-Пловдив. 10. 2020.
2. Georgiev K., S. Krasteva, K. Todorova-Plachiyska, M. Kalaydzhieva, M. Stoilova-Todorova. Application of EF Braces appliance in the treatment of distal bite-pilot study, EOS. 2021.
3. Georgiev K., S. Krasteva. Cephalometric assessment of the EF Braces appliance application in distal bite treatment. 4th Congress of the Balkan Association of Orthodontic Specialists. Ohrid. 09.2020.