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EVALUATION OF THE EFFECT OF A TWIN BLOCK AND A MODIFIED FUNCTIONAL DEVICE ON UPPER AIRWAY VOLUME AND PULMONARY FUNCTION IN PATIENTS WITH A DISTAL OCCLUSION

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The study was devoted to the comparison of the effectiveness of orthodontic treatment of skeletal forms of distal occlusion using a modified functional appliance and a twin block in terms of the impact on changes in the size of the upper airways and pulmonary function in patients with retrograde mandibular position and upper airway narrowing. The anthropometric and spirometric parameters in the dynamics of orthodontic treatment of 104 children aged 7 to 13 years with skeletal forms of distal occlusion and upper respiratory tract pathology in the period of malocclusion, at the peak of growth (CS3 and CS4 – pubertal stages) were analyzed. The use of functional equipment is a necessary component of orthodontic treatment of children with skeletal forms of distal occlusion, as it allows to correct bite pathology and improve the functioning of the dentition.

Key words: distal occlusion, twin block, modified functional appliance, anthropometry, spirometry.

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ОЦІНКА ЕФЕКТУ ТВІН-БЛОКУ МОДИФІКОВАНОГО ФУНКЦІОНАЛЬНОГО ПРИБОРУ НА ОБ'ЄМ ВЕРХНІХ ДИХАЛЬНИХ ШЛЯХІВ ТА ЛЕГЕНЕВУ ФУНКЦІЮ У ПАЦІЄНТІВ З ДИСТАЛЬНИМ ПРИКУСОМ

Дослідження було присвячено порівнянню ефективності ортодонтичного лікування скелетних форм дистального прикусу за допомогою модифікованого функціонального апарату та твін-блоку щодо впливу на зміни розмірів верхніх дихальних шляхів і легеневої функції у пацієнтів з ретрогнатичним положенням нижньої щелепи та звуженням верхніх дихальних шляхів. Проведено аналіз антропометричних і спірометричних показників в динаміці ортодонтичного лікування 104 дітей віком від 7 до 13 років із скелетними формами дистального прикусу та патологією верхніх дихальних шляхів у періоді змінного прикусу, на піку зростання (CS3 і CS4 – пубертальні стадії). Застосування функціонального апарату є необхідною складовою ортодонтичного лікування дітей з скелетними формами дистального прикусу, оскільки це дозволяє виправити патологію прикусу та покращити функціонування зубо-щелепової системи.

Ключові слова: дистальний прикус, твін-блок, модифікований функціональний апарат, антропометрія, спірографія.

The work is a fragment of the research project "An integrated approach in the diagnosis and treatment of orthodontic patients with comorbidities", state registration No. 0121U111023.

Distal malocclusion (DM) is one of the most common problems characterized by retroposition of the lower jaw relative to the upper jaw or underdevelopment of the lower jaw and/or protrusion of the maxillary region. This is accompanied by various morphological, psychological, functional and aesthetic changes of varying degrees of intensity. There is a disturbance in the dynamic balance of the muscles of the mouth and tongue, which affects a number of functions in the child, including external respiration, speech, chewing and swallowing. In addition, in case of DM, when there is a lip closure, the interaction between the function of the facial muscles and the psyche has noticeable manifestations. Deformity of the facial skeleton and facial imbalance lead to a look of withdrawal and timidity, which makes it difficult to communicate with peers.

The development and growth of the craniofacial skeleton are inextricably linked to the upper airway, in particular the pharynx. Narrowing of the upper airway is increasingly recognized as a physiological feature in growing patients with a distal occlusion and mandibular retroposition [9].

Developmental disorders of the upper and lower jaws can affect the pharyngeal volume. Deformities that occur as a result of malocclusion, orthognathic surgery, or orthodontic treatment can change the shape and size of the pharynx.

The results of previous studies indicate a direct correlation between mandibular retrusion and changes in upper airway volume, and this is confirmed by other researchers [1, 2]. Studies show that in case of early detection of skeletal forms of distal occlusion, it is optimal to use functional appliances that

promote the forward movement of the mandible, prevent the movement of the tongue backward and reduce the volume of the upper airways during sleep [11].

Various types of removable functional appliances, such as Activator, Bionator, Frankel and Twin-block, are used to correct distal occlusion anomalies [8].

In 1982, William J. Clark developed a functional appliance called the Twin-block, which is one of the most popular functional appliances for the correction of sagittal malocclusion, causing favorably directed occlusal forces that cause a functional displacement of the n/a [4, 6, 7, 10, 13, 14, 15].

Researchers have different opinions about the effectiveness of its use in normalizing respiratory function. Studies [4, 7, 8, 10, 13, 14] have shown that the use of TB increases the size of the upper airway due to the forward movement of the mandible. However, there are also negative observations [6]. Thus, the effect of TB on the size of the upper airway in the dynamics of orthodontic treatment of distal occlusion remains uncertain.

The purpose of the study was to compare the effectiveness of orthodontic treatment of skeletal forms of distal occlusion using a modified functional appliance and a twin block in terms of the impact on changes in the size of the upper airways and pulmonary function in patients with retrograde mandibular position and narrowing of the upper airways.

Materials and methods. In the course of the study, we developed a modified functional apparatus for the treatment of skeletal anomalies of DM in children with retrograde nuchal position and upper respiratory tract (URT) pathology (Fig. 1).

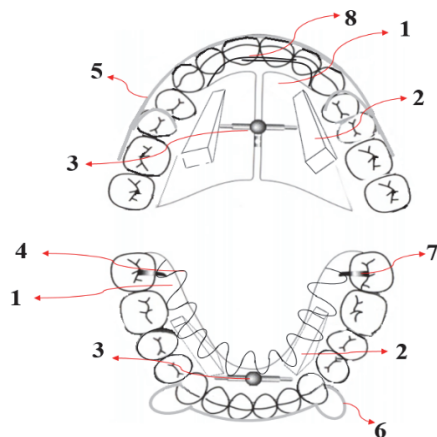


Fig. 1. Design of the proposed functional device. 1. Acrylic bases; 2. Palatine-lingual tracks 3. Upper and lower middle screws; 4. Lower Wavy Bar: side arches with hinges; 5. Upper Bimler's arch; 6. Lower vestibular arch (3x3, from canine to canine) (Labial bow); 7. Lower occlusal feet; 8. Protraction springs.

The tracks in our functional appliance don't exert pressure on teeth, ensuring patient comfort and safety during treatment for skeletal anomalies of the distal occlusion. A hinged arch in the design promotes a natural tongue position, enhancing respiratory function, beneficial for those with breathing issues. The occlusal feet control occlusal plane rotation, preventing extrusion of lower molars while promoting mandible's forward rotation, aiding in bite correction. The device stimulates lower jaw growth, expands the upper airway, and provides aesthetic outcomes. For Class II distal occlusion, protraction springs adjust central incisor inclusion. The device, consisting of removable plates with palatal-lingual tracks angled at 45°, facilitates lateral teeth movement, generating occlusal forces for jaw positioning during swallowing.

One of the important differences between this device and the twin block is that the occlusal surfaces of the teeth are freed from contact with the plastic. This leads to spontaneous closure of the vertical gap in the lateral area and an increase in bite height [12].

The appliance should be worn 24 hours a day and removed only during meals.

We performed orthodontic treatment of 104 children with skeletal forms of DM and narrowing of the URT in the period of malocclusion, at the peak of growth (CS3 and CS4 – pubertal stages) aged 7 to 13 years at the Department of Orthodontics of the P. L. Shupyk National University of Health of Ukraine. Patients were divided into 2 study groups: group I included 53 children with Engle class II, subclass I, and group II included 51 children with Engle class II, subclass II. Depending on the device used for treatment, each group was further divided into 2 subgroups. The 1st subgroup of the first group included 31 children whose orthodontic treatment was carried out with a modified functional appliance, and the 2nd subgroup included 22 children who were treated with a twin block. Similarly, Group II subgroup 1 included 28 children treated with forced spirometry maneuvers (FSM), and Group II subgroup 2 included 23 children treated with TB. 30 children without bite pathology (class I) and respiratory pathology made up the control group.

Spirometric measurements were performed with an SP80B spirometer in accordance with the American Thoracic Society guidelines for standardized spirometry [5]. FSM were performed with a maximum of five attempts until the values and curves were acceptable and reproducible.

Spirometer V 3.2.0, Dolphin Imaging 11.95, and ImageJ 1.52 software were utilized for spirometry and lateral cephalograms. Dental arch width was measured using the A.Pont method, while the anterior segment length was determined by the G.Korkhaus method. The reliability of the studies was assessed using IBM SPSS Statistics v26 2019 with the Chi-square test. The mean changes between groups using the modified functional device and the twin block were analyzed using the independent t-test, considering a P value <0.05 as significant [3].

Results of the study and their discussion. Spirometric tests (FVC, FEV1, FEV1/FVC %, PEF and MEF 25, 50, 75 and 25–75 %) showed reduced values before orthodontic treatment in the study groups compared to patients in the control group (Fig. 2).

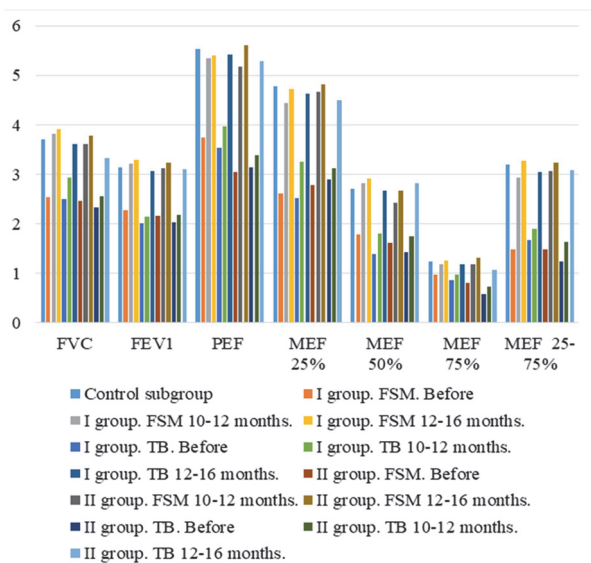


Fig. 2. Comparison of spirometric parameters in the study groups in the dynamics of orthodontic treatment.

Before orthodontic treatment, significant differences were found in the width of premolars, molars and the length of the anterior dental arch in the upper and lower jaws in patients of both experimental groups with a distal occlusion compared to the control group. In the dynamics of orthodontic treatment with both the proposed modified functional appliance and the twin block, anthropometric indicators showed a significant positive trend (Fig. 3–4.).

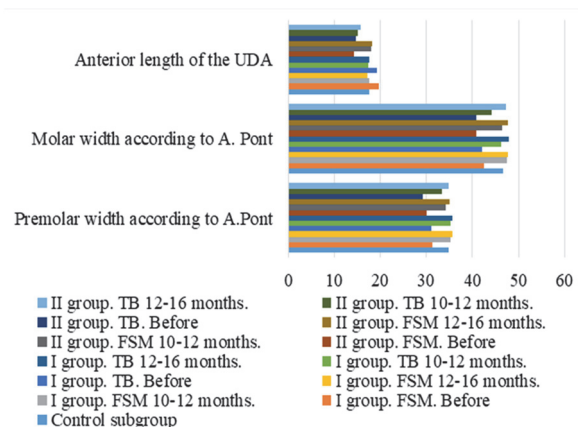


Fig. 3. Comparison of anthropometric parameters of the upper jaw in patients of the study groups in the dynamics of orthodontic treatment.

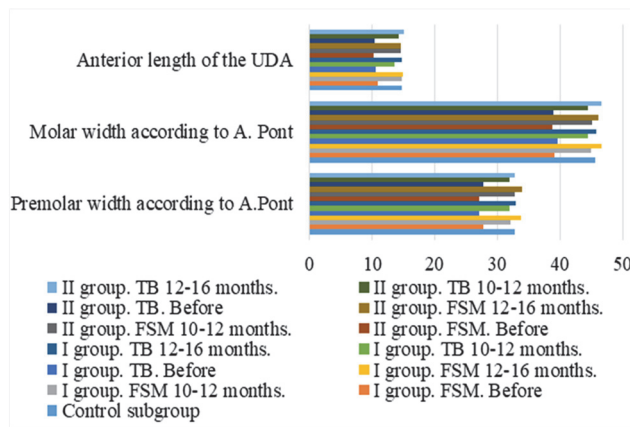


Fig. 4. Comparison of anthropometric parameters of the mandible in patients of the study groups in the dynamics of orthodontic treatment.

Thus, if before the treatment the premolar width in children of group I was 31.22 ± 2.19 mm, then after 12 months of treatment with a modified functional space it was 35.21 ± 4.14 mm, which fully corresponded to the control group (34.76 ± 1.4 mm) and did not differ from the indicators of groups I–II (35.25 ± 3.14 mm), which were treated with a twin block. At the same time, other anthropometric parameters were normalized: molar width and anterior length of the upper dental and lower dental arches.

In group II, similar results were obtained. Thus, in the patients of the study groups, we noted the normalization of occlusal parameters after 10–12 months of treatment.

The results are considered to be expected, since both the modified functional device and the twin-block device contain the same expansion screws on both jaws.

The results showed a decrease in the anterior length of the upper dental arch (UDA) in group I at all follow-up periods, starting from 10–12 months, regardless of the appliance used. However, in patients of group II, the measurement results showed an increase in the anterior length of the upper dental arch in the treatment with a modified functional appliance after 12 months, while this indicator returned to normal in patients who were treated with a twin block after 12–16 months of orthodontic treatment. there was a slight increase in the indicators during 10–12 months and 12–16 months of treatment with a twin block. This result

was made possible by the design of a modified functional device that includes arch extensions to correct the inclination of the upper anterior teeth in patients of group II. And in patients who have been treated with a twinblock for distal occlusion, fixed braces are likely to be required to correct the position of the incisors after the twinblock treatment is completed. This opinion is also confirmed by the results of cephalometric analysis (CR) (Upper 1 to palatal plane, Upper 1 to NA ($^{\circ}$), Upper 1 to NA (mm) and Interincisal angle ($^{\circ}$).

The results of the dimensions of the anterior length of the lower dental arch were not affected by the type of orthodontic appliance used, and its values normalized after 10–12 months in all patients.

The conclusions of previous research works indicate a direct relationship between mandibular retrusion and changes in the volume of the upper airway, and this is supported by the data of other scientists [1, 2]. Studies show that in the case of timely detection of skeletal forms of distal occlusion, the best choice is the use of functional devices that promote forward movement of the mandible, counteract the backward movement of the tongue and reduce the volume of the upper airway during sleep [9, 11, 13]. The performed research work confirmed the stabilization of spirometric parameters (FVC, FEV1, FEV1/FVC %, PEF and MEF 25, 50, 75 and 25–75 %) during treatment with a modified functional device for 10–12 months of treatment, and the use of a twin block took place for 12–16 months. In the course of orthodontic treatment, regardless of the use of a modified functional device or a twin block, all anthropometric indicators showed significant positive dynamics, almost all of them stabilized in the period from 10 to 12 months. The results were achieved through the use of an arch extender to correct the inclination of the upper front teeth. Patients who have received DM treatment with the use of a twin block are likely to require the use of fixed braces to correct the position of the incisors after the twin block treatment is completed. This opinion is confirmed by the results of the CR analysis (Upper 1 to palatal plane, Upper 1 to NA ($^{\circ}$), Upper 1 to NA (mm) and Interincisal angle ($^{\circ}$).

Conclusions

1. The studies have shown normalization of spirometric parameters (FVC, FEV1, FEV1/FVC %, PEF and MEF 25, 50, 75 and 25–75 %) in treatment with a modified functional device after 10–12 months of treatment, and in the case of using a twin block – after 12–16 months.

2. In the dynamics of orthodontic treatment with both the proposed modified functional appliance and the twin block, all anthropometric indicators showed significant positive dynamics, almost all of them normalized in the period from 10 to 12 months. The results are expected, since both FSM and TB contain the same expansion screws on both jaws.

3. Only in patients of group II the results of measurements showed an increase in the anterior length of the upper dental arch in FSM treatment after 12 months, while in TB treatment – after 12–16 months of orthodontic treatment. This result was achieved due to the inclusion of an arch extender to correct the inclination of the upper anterior teeth.

4. Patients who have been treated with a twin block for DM are likely to require fixed braces to correct the position of the incisors after the completion of treatment with a twin block. This opinion is confirmed by the results of the CR analysis (Upper 1 to palatal plane, Upper 1 to NA ($^{\circ}$), Upper 1 to NA (mm) and Interincisal angle ($^{\circ}$).

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ROLE OF CYSTATIN C IN THE DIAGNOSIS AND PROGNOSIS OF THE DEVELOPMENT OF CARDIORENAL SYNDROME IN COMORBID PATIENTS WITH ARTERIAL HYPERTENSION

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The purpose of our study was to determine of diagnostic and prognostic role of cystatin C in the development of cardiorenal syndrome in the case of arterial hypertension syndrome and maximum comorbid conditions. 111 patients and 20 persons of the control group were examined. In the current examination process, they were divided into 4 groups depending on the presence of comorbid pathology in them: patients with arterial hypertension – 1 group – 22 people; patients with arterial hypertension in combination with obesity – group 2 – 30 people; arterial hypertension in combination with type 2 diabetes – group 3 – 31 people; patients with hypertension, type 2 diabetes and obesity – group 4 – 28 people. The level of cystatin C in the examined cases with arterial hypertension and various comorbidities was significantly higher compared to individuals of the control group. Significant effect of the cardiotrophin-1 residue on cystatin C. An increased level of cystatin C is associated with an increase in blood pressure, the level of cardiotrophin-1, catestatin, which ensures its role in the early development of nervous and cardiovascular complications in patients with arterial hypertension with various hormonal comorbidities and confirms the significance of the activity of adipose tissue in the development of kidney dysfunction.

Key words: arterial hypertension, type 2 diabetes mellitus, obesity, cystatin C, cardiorenal syndrome.

І.П. Дунаєва

РОЛЬ ЦИСТАТИНУ С В ДІАГНОСТИЦІ ТА ПРОГНОЗУВАННІ РОЗВИТКУ КАРДІОРЕНАЛЬНОГО СИНДРОМУ У КОМОРБІДНИХ ПАЦІЄНТІВ З АРТЕРІАЛЬНОЮ ГІПЕРТЕНЗІЄЮ

Метою нашого дослідження було визначення діагностичної і прогностичної ролі цистатину С в розвитку кардіоренального синдрому у пацієнтів з артеріальною гіпертензією і різними коморбідними станами. Обстежено 111 хворих та 20 осіб контрольної групи. В процесі ретельного обстеження вони були розподілені на 4 групи в залежності від наявності в них коморбідної патології: хворі на артеріальну гіпертензію – 1 група – 22 особи; хворі на артеріальну гіпертензію в сполученні з ожирінням – 2 група – 30 осіб; артеріальна гіпертензія в сполученні з цукровим діабетом 2 типу – 3 група – 31 особа; пацієнти з артеріальною гіпертензією, цукровим діабетом 2 типу та ожирінням – 4 група – 28 осіб. Рівень цистатину С у обстежених пацієнтів з артеріальною гіпертензією та різною коморбідністю був значуще вищим у порівнянні з особами контрольної групи. Значущий вплив на цистатин С здійснює кардіотрофін-1. Підвищений рівень цистатину С асоційований з підвищенням артеріального тиску, рівнем кардіотрофіну-1, катестатину, що засвідчує його роль в ранньому розвитку ниркових і серцево-судинних ускладнень у хворих на артеріальну гіпертензію з різною коморбідністю та підтверджує значущість гормональної активності жирової тканини в розвитку дисфункції нирок.

Ключові слова: артеріальна гіпертензія, цукровий діабет 2 типу, ожиріння, цистатин С, кардіоренальний синдром.

The work is a fragment of the research project “To determine the features of immunocytokine imbalance in comorbid patients with arterial hypertension and type 2 diabetes mellitus and cardiovascular and renal complications”, state registration No. 0123U101711.

Currently, early diagnosis of kidney dysfunction is based on biological markers that can be used for screening and diagnostic purposes to identify stages (condition biomarkers), risk assessment (antecedents), prognosis and outcome (predictive), and treatment efficacy.