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The Results of Orthodontic Treatment Using Computer Design of Structures.

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ABSTRACT

The article deals with the use of mathematical background and computer modeling in the process of treatment dental apparatus engineering. Drawing on mathematical calculations, veracity of which is validated by the results of experimental research, there in the clinic it has been used treatment appliance made of elastic polymer with set-up parameters. It has been proved the efficiency of use of the suggested structure of removable treatment orthodontic appliance.

Keywords: Anomalies of dentition occlusion, mathematical modeling, basis polymers, orthodontic apparatus.

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INTRODUCTION

Anomalies of dentition hold one of the first ranks in maxillofacial diseases. Functional and morphologic deviations are found to be in 75% children in the period of transitional dentition and the prevalence of which exceeds caries frequency and other dental diseases [1].

The level prevalence of transverse occlusion among children and teenagers is from 0, 3 to 1,9% of all anomalies [2,3]. Self-regulation of transverse occlusion does not take place. Shaped occlusion anomaly implies disturbed normal dentition function [4-7]. It is accepted that asymmetric constriction of maxilla dentition causes transverse occlusion development. To eliminate it in children with early transitional dentition the acrylic polymer structures with active metallic elements to be regularly activated for achieving treatment effect are used. Such structures induce sense of discomfort in a patient. Frequently, they cause patient's refusing treatment. It is well-known that negative influence of residual monomer can provoke allergic response of oral mucosa and toxic reactions of the whole organism [8-10]. In this connection, at present, new non-acrylic materials without monomers, having unique elastic properties, have been increasingly introduced into dentistry. The above prompts to further scientific research on using elastic materials.

The objective of the research

By methods of system analysis to determine possibility of application of elastic non-acrylic polymers for treatment anomalies dentition occlusion.

METHODOLOGY

To attain the set objective one uses the technologies of computer-aided design (CAD-system). Such systems enable to design treatment dental prosthesis from definite material in terms of specific properties. CAD systems, based on three-dimensional geometry, have been widely used in designing broad range of articles. Interesting and important stage in this process is carrying out mathematical modeling of deflected mode of denture-supporting tissues and determination of required parameters of orthodontic apparatus with regulation of charging capacity.

Up-to-date home and foreign elastic polymers "Evidsun" Russia, "Denta-D" Italy, "Acry-Free" Israel were used in the research work. This group of materials is characterized by elasticity, high resistance to dynamic alternating charges. This allows to produce fine and delicate dental structures. On the basis of the laboratory of theoretical mechanics and mechatronics of Kursk University, jointly with the head of the chair, Doctor of Engineering, A.S. Yatsun, it has been designed solid-state three-dimensional maxilla allowing for changes and shift in the set of teeth that takes place under the impact of appliance charge. This modeling resulted in variants of deflected mode of appliance model showing the division of charge in structure capacity that was divided into small segments and at each point of segment the function of rigidity was determined.
The clinical research included examination, treatment and supervision of two groups of patients involving 30 children in each aged from 6 to 9 with diagnosis « transverse occlusion, provoked by asymmetric constriction of dentition of maxilla». The first, control group was provided with the treatment by removable traditional mechanical orthodontic apparatus, made of basic acrylic material "Ftorax". The regime of activation was two times a week to 1/4 of the screw turnover. The group of observation was provided with the treatment by removable orthodontic apparatus made from elastic polymer – "Dental-d" with dosed pressure regulator. The appliances were molded according to previously corrected dentition form for permanent use. Sociological, biometrical and clinical methods of research were applied to analyze the dynamic changes occurring under treatment. The obtained research data were statistically processed.

MAIN BODY

As a result of experimental apparatus modeling in accordance with physical-mechanical properties of constructional material meaning for correction of constricted dentition area and, at the same time, sparing soft tissues of prosthetic bed it has been ascertained that it is necessary to use damping elements for apparatus dosing charge intensity. . Depending on elasticity of structural material it is optimal to place two, three elements of charge control. As result of the mathematical modeling, on the basis of obtained data, an orthodontic apparatus for maxilla with regulators of graduated pressure in the form of flexible spring, made

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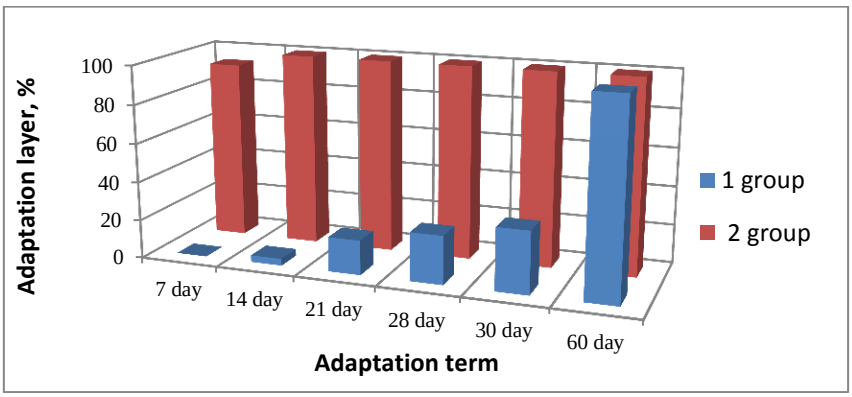
simultaneously of the same material as the apparatus, has been designed. Patent of RF #98120 for this design has been taken out. As a result of physico-mathematical researches in the capacity of constructional material the polymer "Dental-D" is chosen for clinical use.

According to the data, obtained during statistical processing of the questionnaires, all the children were adapted to treatment orthodontic apparatus, but adaptation terms in the groups considerably varied. The analysis of results in terms of comparative aspect is reflected in picture 1.



Picture 1: Comparative characteristics of patients' adaptation terms

Difference between the duration of the period of active treatment was per 33±0.03 ($p < 0,05$) days. By analyzing the obtained data of the adaptation terms it is necessary to state that using mathematically substantiated treatment structure considerably reduces the period of patient's adaptation to the apparatus.
The data of dynamic local changes of the constricted dentition of maxilla were eliminated. But, in the first group the average value of extension was 0,38 ±0.12 ($p<0,05$) mm, in the second group–0,45±0.05 ($p<0,05$) mm, that is, monthly extension of maxillary dentition in the second group was more intensive than in the first one.

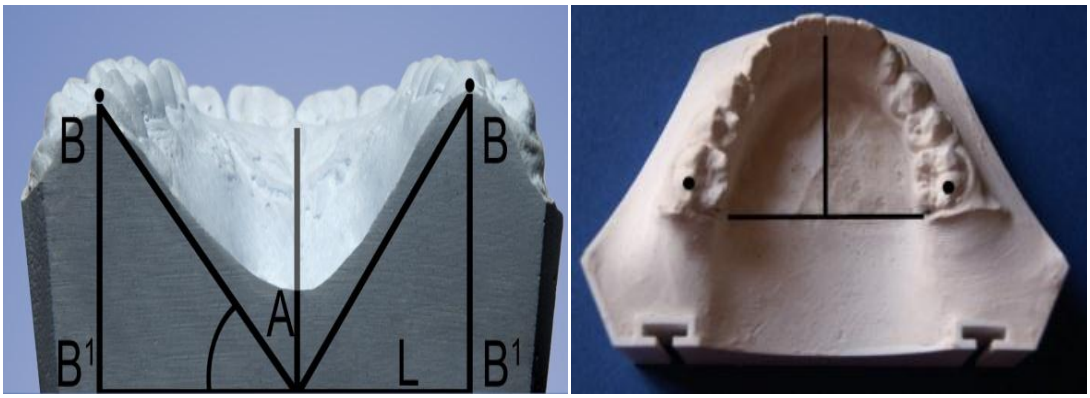
In the presented tables #1-2 below there are the dynamic results of biometric analysis of plaster models.

Table 1: Dynamics of extension of constricted sites of maxillary dentition in terms of comparative aspect

№ Group	Input data, mm	1month, mm	2 month, mm	3 month, mm	4 month, mm
Group 1	1,89±0.12*	1,54±0.11*	1,17±0.10*	0,79±0.05*	0,40±0.02*
Group 2	1,80±0.11*	1,35±0.07*	0,9±0.04*	0,45±0.03*	

Note. * – Confidence intervals were calculated for Student distribution at significance level <0,05.

The obtained data of biometrical measuring according to the methods [1] allowed to track the dynamics of axial inclination of the examined teeth and changes of the dentition width, picture 2.



Picture 2: Biometric research of diagnostic models

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Table 2: Comparative dynamics of changes of angle value of axial inclination of abutment teeth

№ group	Input data	After the 1st month of treatment	After the 2nd month of treatment	After the3d month of treatment	After the 4th month of treatment	After the 5th month of treatment
Group I	47.21±0.38*	47.18±0.38*	47.07±0.39*	46.97±0.38*	46.95±0.38*	46.0±0.36*
Group II	46.26±0.39*	45.99±0.37*	45.61±0.35*	45.24±0.36*	45.09±0.37*	

Note. * – Confidence intervals were calculated for Student distribution at significance level < 0,05.

In all patients of the first, control group the angle value BAB1 at the stage of active treatment changed to a lesser extent, per 0,11±0.06 ($p<0,05$)degree, whereas in the children of the second group decrease in angle BAB1 was per 1,17±0.02 ($p<0,05$) degree, that was 1,06±0.04 ($p<0,05$) degree greater. The value of segment B-B1 in the patients of the first group decreased per 2,11±0.56 ($p<0,05$)mm., whereas in the patients of the second group – per 0,03 ±0.01 ($p<0,05$)mm.

CONCLUSION

The suggested methodology via designed treatment structure proves to be effective on reducing active and adaptive period of treatment that has substantial advantage over classical methods of treatment of maxillary dentition constriction.

SUMMARY

By mathematical modeling at the stage of designing medical dental appliances using computer technologies the objective possibility of structure validity, its primary elements in terms of physical-mechanical properties of structural material occurs. Computer modeling of clinical situations allows to take into account the set of individual factors providing treatment efficiency.

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