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Development And Preliminary Evaluation Of Modern Automated Technologies Training Manual Skills For Dental Specialties In The Module “Unremovable Prosthesis”.

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ABSTRACT

The development of practical skills using simulation training eliminates the risk to life and health of the patient, provides a personalized approach to learning, the possibility of multiple mining skill of manipulation and brings to automatism, and objective control of the quality of its execution. The objective of this study was to determine the effectiveness of a simulation method of teaching manual skills in the module "unremovable prosthesis" in a clinical setting. The use of an interactive computer simulation CDS 100 provides a higher level of acquisition, and the main "survival" of practical skills, confirmed by subsequent clinical practice, compared with the classical form of education.

Keywords: training module, unremovable prosthesis, mechanical preparation of hard tissues, manual skills, a computer simulator.

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INTRODUCTION

The changing of the social development needs in condition of reforming of the modern Russian education determines the gradual transition in the innovative development mode.

The present level of the dental technology development brings qualitatively new requirements on methods of training practical skills at the undergraduate and postgraduate education. The urgency of the problem is confirmed by an extensive legislative framework [1].

Unfortunately, the current method of the training manual skills on phantoms does not provide an adequate level of practical skills [2]. According to the traditional system of practical training of medical personnel in Russia the high risk for patient's health is presented; medical facilities are used inefficiently and for other purposes; to the implementation of educational manipulation requires the presence of a mentor; training depends on the schedule of the clinic and the availability of the studied pathology; there is no possibility of a repeat of the manipulation or intervention. In addition, evaluation of practical training of students is carried out subjectively, there is no single system of objective evaluation [3].

Nowadays, the traditional system of practical training of dentists does not meet safety requirements during the providing medical care. And even now the requirements according to which the provision of medical care is allowed to students not only successfully passed the required theoretical knowledge but also practical skills on models (phantoms) are not fully complied in many medical schools.

The development of practical skills through simulation training eliminates risk to life and health of the patient and the student, allows to conduct classes on individualized education program without regard to the mode of operation of the clinics and the work schedule of the teacher, allows for multiple skills training and bringing to perfection of manipulation, provides the objective control of the execution quality, easily simulates a rare disease and clinical cases, to reduce the stress that occurs in young professionals when carrying out the first procedures on real patients [4]. There are three main areas of simulation training in the modern medicine [5]:

1. Standardized patient
2. Robots – simulators of the patients or phantoms with simple design
3. Virtual simulators of the certain manipulations and surgical interventions

The medical community has long paid attention to the new possibilities of simulation technologies [6]. In 2008, the new magazine profile "Virtual Technologies in Medicine" was registered and began to publish in Russia. In 2012, all-Russian public organization "Russian society is a simulation training in Medicine" was established that promotes the introduction of a medical education and practical health care simulation technology for the acquisition of skills, certification and certification, implementation of scientific research and testing of medical equipment and without the risk of technologies for patients. Almost all universities have acting skills centers. However, there are a number of the problems of modern simulation training, typical for medical education in general and dental in particular such as: the lack of uniform methods and standards of training, adopted at the world level; training centers of the universities are divided; the inconsistency of individual programs, the lack of continuity of individual courses; lack of teachers holding a simulation training techniques; low motivation of teachers and students; the lack of funding.

Thus, further development, testing and introduction in the educational process a simulation training programs on various sections of dentistry, recommendations on methodological and organizational support of a simulation training, the development of standard designs and models of equipment simulation centers at various levels, uniform criteria for assessing the effectiveness of a simulation training, unified system qualification and certification of students on the basis of simulation technologies and the establishment of the order of their admission to the clinical activities; uniform criteria for assessing the level of practical skill, which determined the relevance of this study [1].

MATERIAL AND METHODS

The research was a two-stage prospective non-randomized study.

Criteria of conformity. The inclusion of students in the study of the first stage was carried out on the basis of voluntary consent. The criteria for inclusion in the study were the following parameters:

- voluntary consent and choice of future specialization and professional activity in the specialty "orthopedic dentistry";
- an identical higher education institution, a course and an educational standard for training in the mode "Simple prosthetics. Fixed prosthetics";
- lack of a previous secondary education in the specialty "orthopedic orthomedicology".

The exclusion criteria from the study were the following parameters:

- choice of future specialization and professional activity in other specialties and / or unwillingness to participate in the study;
- The presence of a previous secondary education in the specialty of "orthopedic stomatology".

The inclusion of participants in the Phase 2 study was carried out on the basis of voluntary consent. The criteria for inclusion in the study were the following parameters:

- voluntary consent, successful completion of the course of professional retraining and the availability of a certificate of a specialist in the specialty "orthomedical orthotics";
- compulsory participation in identical groups of the 1st stage.

The exclusion criteria from the study were the following parameters:

- lack of a certificate of a specialist in the specialty "orthopedic dentistry" and / or unwillingness to participate in the study;
- non-participation in the 1st stage of the study.

The basis of standardization of participants in the study at all stages of the study was compliance with inclusion and exclusion criteria.

Terms and conditions

The work was carried out at the departments of Propaedeutic Dentistry (head of the department A.N. Morozov), Postgraduate Dentistry Department (head of the department B.R. Shumilovich) and Department of Public Health and Healthcare (Head of the Department, V.P. Kosolapov) "Voronezh State Medical University named after N.N. Burdenko" of the Ministry of Health of the Russian Federation and the laboratory of digital medical research at the Voronezh State University of the Ministry of Education and Science of the Russian Federation.

The first stage of the study was conducted during the period January-May 2013, the second stage - in the period September-December 2016.

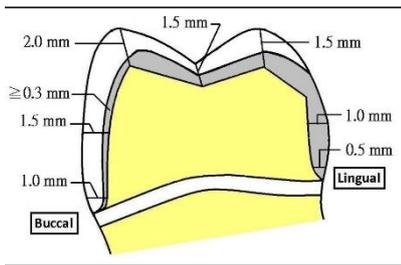
The material of the study of the first stage was submitted by 82 people, 3-year students of the module "Simple prosthetics, fixed prosthetics". All the students were divided into two groups - a control group (42 people) where the manual skills were trained according to the traditional method using standard phantom training and a research group (40 people) where the virtual simulation method of odonto preparation of supporting teeth was used using dentists simulator V generation CDS 100 (EPED, Taiwan).

The material of the research of the second stage was presented by 48 people who participated in the 1st stage, in 2016 young specialists from various dental institutions in Voronezh passed professional training courses in the specialty "orthopedic dentistry". All participants in the study were divided into two groups: a control group (22 people) where manual skills training at the third year of the university program was conducted according to a traditional method using standard phantom training and a study group (26 people) where, at the same time, virtual simulation technique of preparation of supporting teeth using a V-generation dental simulator CDS 100 (EPED, Taiwan).

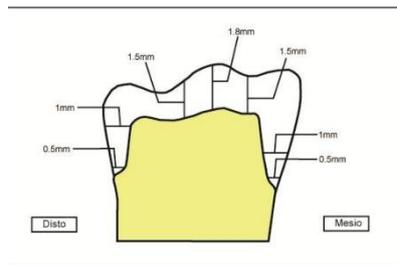
The study was conducted on the preparation of supporting teeth for a cermet construction as the most popular and demanded type of permanent prosthesis.

Criteria for assessing the quality of preparation at the first stage of the study in the control group were the results of the check-lists for this module and the successful delivery of the test, in the study group -

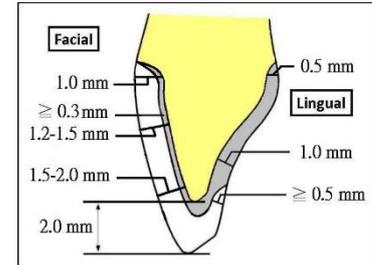
the result of the passed control preparation on the simulator on a 100-point scale and according to the requirements presented in Fig. 1.



Molar preparation (4.6).



Premolar preparation (4.5).



Incisor preparation (1.1).

In addition to the preparation geometry, which includes the preparation volume, the correlation of angles and the quality of the shoulder, the program evaluates the amount of damage to adjacent teeth, the smoothness of the surface and the perforation of the pulp chamber. A 15% tolerance of deviation from the "ideal" parameters was established, minus the points for each violation of the preparation protocol. The minimum number of points required to successfully pass the test is 70.

Criteria for assessing the quality of the preparation at the 2 stage of the study in the control group and in the study group were the results of scanning the models cast from the working impressions obtained on clinical reception with the Zirkozahn arti s600 scanner.

Ethical examination

The study was approved by an independent ethical committee of the Voronezh State Medical University. N.N. Burden-ko. All participants in the study received voluntary informed consent to the processing of personal data. Additionally, in the 2nd stage of the study, voluntary informed consent was obtained from all patients for the use of the obtained clinical data for the purpose of the study.

Statistical analysis

Statistical processing of data was carried out using the standard package Statistica 6.1. The standard software packages were verified before they were applied in the form of calculating artificially standardized data with a known result, which made it possible to characterize the work of a particular program. When comparing the qualitative characteristics, Fisher's exact probability test was used, as well as the χ^2 criterion with Yates's correction.

As a method of multivariate statistics, cluster analysis using the K-means method was used to determine the types of reactions to the level of the maximal skills according to the methods for obtaining them.

RESULTS AND DISCUSSION

During the first stage of the study group, a training course was offered on the CDS 100 computer simulator from EPED Company (Taiwan, Figure 2). The level of correspondence of the clinical situation was 97%. The principle of operation of the simulator is built on two-way communication trekking computer systems and sensors located on the tip and the phantom (Fig. 3), which makes it possible to keep the computer objective scrutiny of the operations performed at various kinds of mechanical dental treatment.

The technical capabilities of the device include both a training mode with theoretical and practical parts, and an examination mode with the ability to specify the type and parameters of the preparation.

The technical capabilities of the device include a training mode with the theoretical and practical parts, and test mode with the ability to set the type and parameters of preparation. The list of the proposed

tasks consists of preparation for fixed prosthetic design (Fig. 4, crown-molded, metal, metal-free ceramics, veneers, etc.) of various anatomical teeth toiletries, a total of 6 lessons.

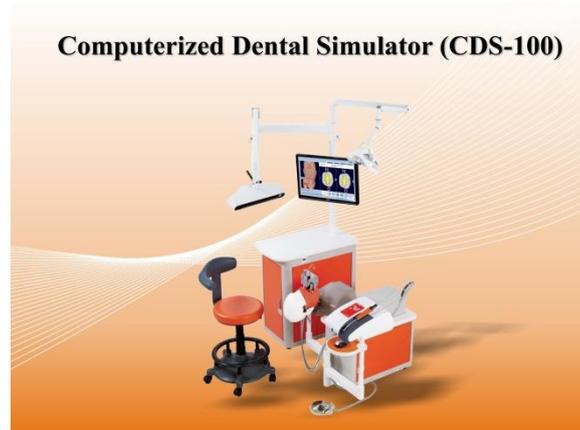


Fig 2: Computerized Dental Simulator CDS 100.

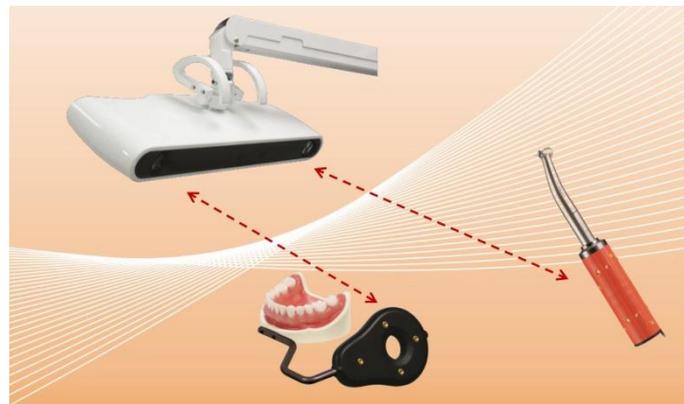


Fig 3: Key nodes of the computerized dental simulator CDS 100.



Fig 4: Preparation, removable prosthetics

The device software is available in English and understandable even for the unprepared user. The volume of the simulation of clinical situations covers almost the entire list of diseases of teeth hard tissues.

The apparent advantage of the device, which has no analogues in the domestic market, is the ability of user's tactile contact with phantom, followed by the evaluation of errors and their corrections (Fig. 5-6). In addition, there is the constant possibility of a software update.

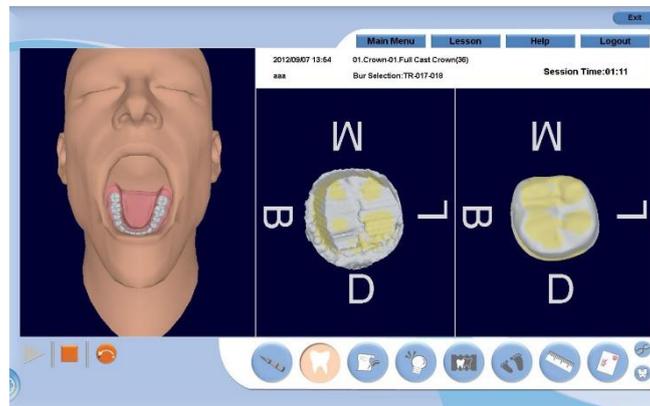


Fig 5: Preparation for fixed construction. Comparative characteristics

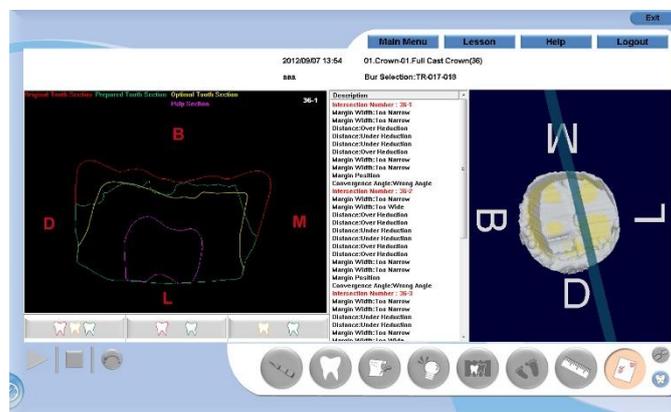


Fig 6: Preparation for fixed construction. Control of the preparation volume

Currently, for the medical schools, equipped with phantom classes, manufacturer presented new device DDS 100, which consists of the set of key components of computer simulation and designed for upgrade the existing equipment with the creation of appropriate technical capabilities.

As already mentioned, the evaluation of the effectiveness of training on the simulator was carried out on the basis of the results of a 3-month training cycle.

Unfortunately, currently existing methods of training manual skills on phantoms do not provide adequate practical skills level.

The main disadvantages of existing training methods are:

- work on standard phantoms eliminates "feedback";
- teacher's control over the key manipulation parameters (volume of removed tissue, geometry of the preparation, etc.) is only subjective;
- planning of the manipulation volume, control of some parameters (surface smoothness, damage to adjacent teeth, damage to the pulp chamber, etc.) is impossible.

Precisely for the above reason, the main criteria for the effectiveness of the teaching methodology were the results of the 2nd stage of the study, where an objective clinical evaluation of the quality of tooth preparation of supporting teeth was performed.

According to the survey of participants in the 2nd stage of the study, the greatest difficulties were caused by manipulations associated with the formation of an adequate shoulder of the supporting teeth, which is completely correlated with the literature data.

At the 2nd stage, the working impressions taken from the clinical reception of the participant's study were moved to the dental laboratory where the bite-fixing model was cast (Figure 7), which was later placed in the scanner, in which the clinical situation was simulated (Fig. 8) and the subsequent modeling of the framework of a non-removable design, the parameters of which can be transferred to CadCam (Figure 9) and the image of the goat frame on the model (Fig. 10). The scanner was gleamed on the screen a double image with indications of the points of necessary correction with improper preparation and the need to refine the supporting teeth, (Fig. 11).



Fig 7: Virtual image of the model in the scanner



Fig 8: Virtual image of the dentition in the scanner



Fig 9: Modeling the frame and preparing model for the CadCam router

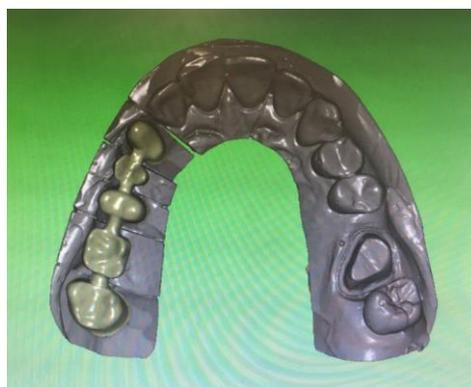


Fig 10: Finished frame on the model

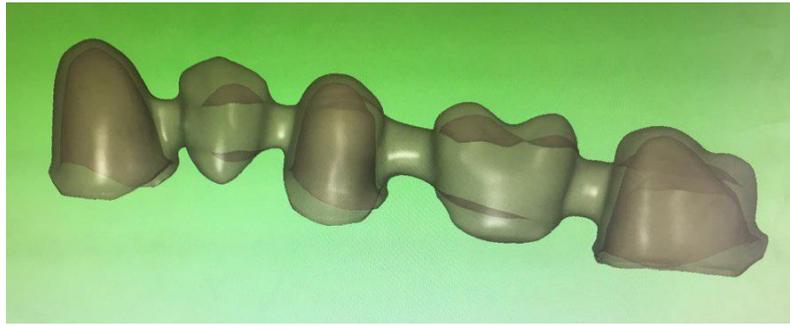


Fig 11: The type of the virtual framework if it is necessary to mechanically refine the supporting teeth

The number and causes of corrective modifications were subjected to static processing by the above method.

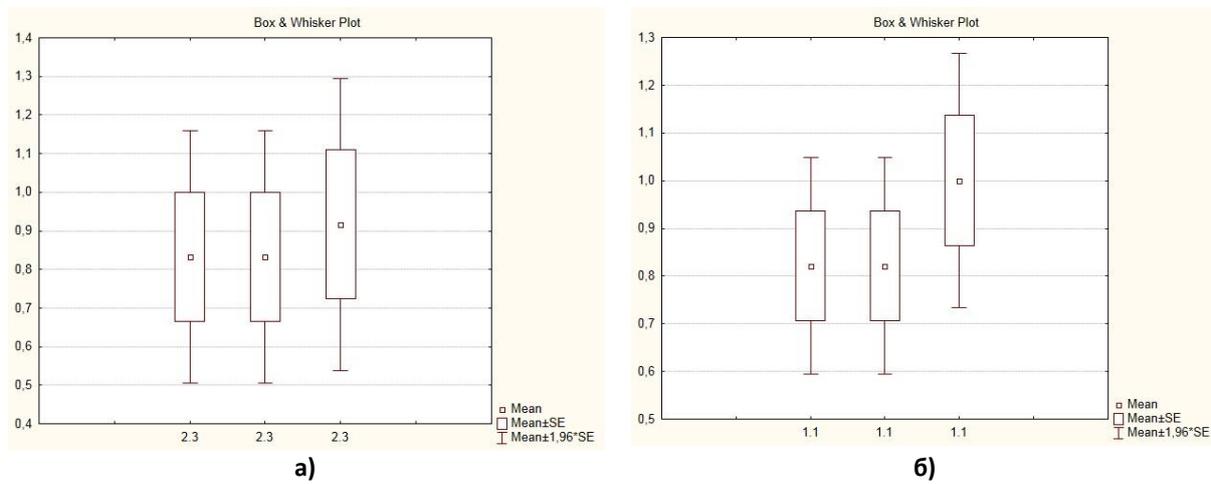


Fig 12: Dynamics of the quality of manual skills in the control group according to the correlation analysis of variance analysis by Friedman, where: a) 1 stage of the study; b) 2 stage of the study.

Fig. 12 shows the dynamics of the quality of manual skills at various stages of the study using the traditional method of training in phantoms where the first column shows the conicity index of the prepared supporting tooth, the second column shows the occlusal ratio and the third shows the adequacy of the shoulder (control group).

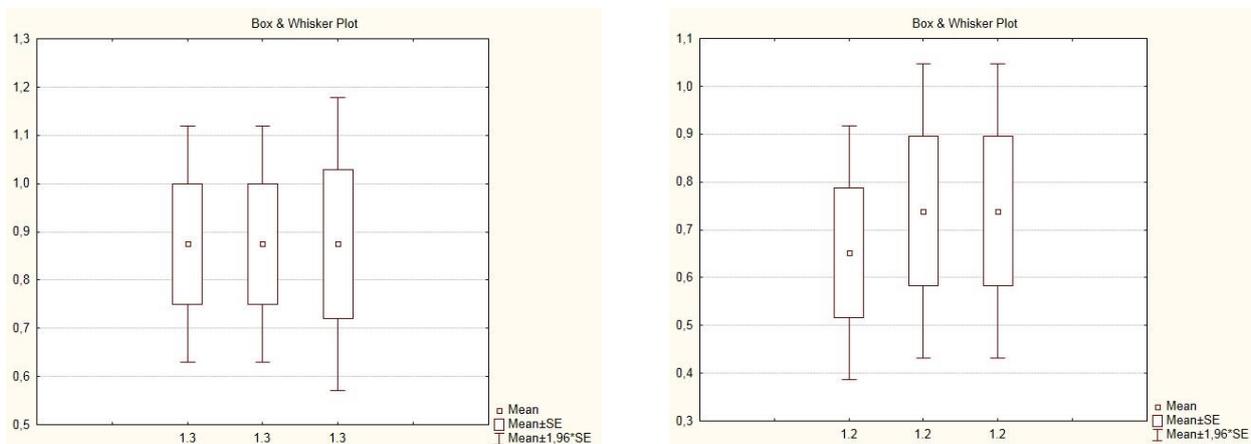


Fig 13: Dynamics of the quality of manual skills in the study group according to the correlation analysis of variance analysis by Friedman, where: a) 1 stage of the study; b) 2 stage of the study.

Fig. 13 shows the dynamics of the quality of manual skills at various stages of the study when using the virtual simulation training methods. Where, as in the previous case, the first column shows the conicity index of the prepared supporting tooth, the second column shows the occlusal ratio and the third one shows the adequacy of the shoulder (study group).

Thus, analyzing the results of the studies obtained in the control group, it can be argued that the main reason for the need for additional mechanical correction of supporting teeth at both the 1st and 2nd stage of the study is due to the inadequacy of tooth shoulder with an ANOVA factor of 1.1 for 1 stage of the study and 1.15 for the 2 stage, which indicates the statistical identity of the pre-speakers of this group.

Analyzing the results obtained in the study group, we found out the absence of a statistically significant difference in the quality of the teeth shoulders performed at stages 1 and 2 of the study, ANOVA factor 0.9, which indicates the statistical significance of such a predictor as a preliminary acquisition of the automatism of movements acquired with the simulator.

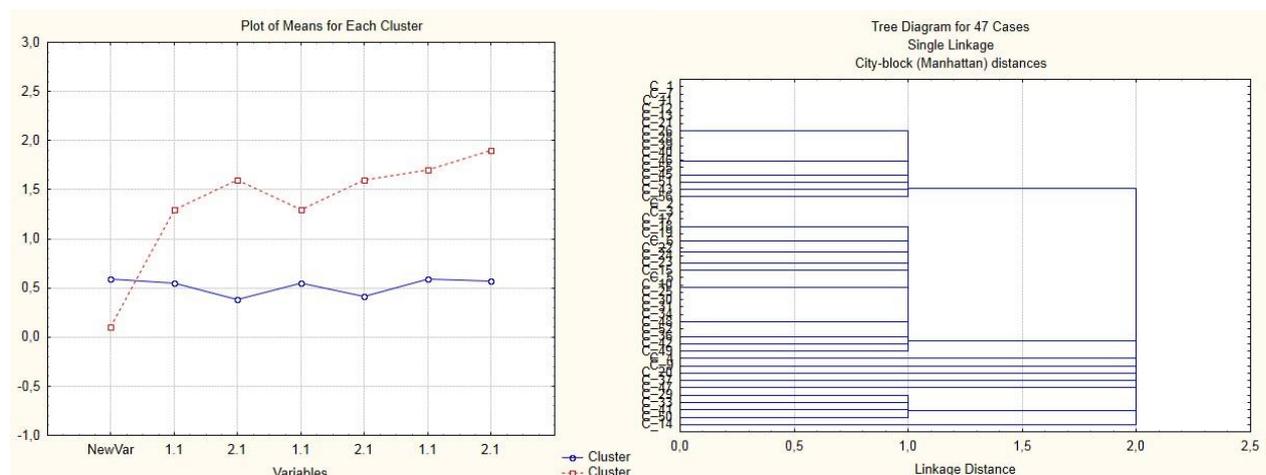


Fig 14: Dynamics of the number of additional corrections of supporting teeth in groups according to the cluster analysis data, where:

red – control group; blue – study group.

The results of the cluster analysis are shown in Fig. 14. In a cluster, there is a difference in the mean values of a variable between group members. The average value of the variable in the study group is significantly lower than in the control group, and the range of variation in the mean values of the variable has no significant value ($p \leq 0.1$) and does not affect the objectivity of the parameters being evaluated.

Such a difference in the average values of the variable can be attributed to the clinical effectiveness of the methodology used to teach manual skills. Since immediately after the 1st stage of the study the average values of the variable differed insignificantly in different groups, in the given variational series of the second stage not only the mean values of the variables in different groups changed, but also these values differ significantly.

Thus, the use of computer simulation of dental CDS 100 in conjunction with the basic methods of teaching manual skills on the stage of high school students learning offers a high acquisition rate, and most importantly 'survival' of practical skills, which certainly contributes to better training of a dentist.

Based on the foregoing, it seems very promising widespread use of computer training with a simulation of feedback effects on stages not only the university, but also post-graduate education, as its use is possible to obtain a convincing practical effect. The application in the educational program CDS 100 can achieve a significant reduction in time spent to achieve the intended results, use an objective assessment of learning outcomes, both on intermediate and at the final stages, and from the very beginning of training to bring the level of manual skills in line with modern requirements of the practice of dentistry. Despite the relatively high

cost of the device, the appropriateness of its mass application in the pedagogical process is dictated by its high efficiency in the training of students, medical residents, graduate students, as well as beginners.

CONCLUSION

Computerized dental simulator CDS 100 is the first and only simulation system of training manual skills in the domestic market with the "feedback" function, a unique development of the Taiwan Company EPED. The device is based on a computer control performed on a phantom manipulation of the machining of dental hard tissues in the clinic of the therapeutic and prosthetic dentistry with the assessment and the ability to correct mistakes. In addition to training, the system comprises program-examiner, which leads to a number of its undeniable advantages, namely:

- the opportunity to continuously improve the level of manual skills and learning new technologies from the point of view of jurisprudence;
- simulated clinical situation in real time to 97%;
- reduction of the possibility of medical errors in future clinical activities;
- high level of students' academic achievement;

That allows to recommend the widespread use of computer dental simulator CDS 100 in conjunction with the basic methods of training manual in the university and during the training of post-graduate students and young professionals to ensure a high level of acquisition, and the main "survival" of practical skills, which in turn undoubtedly contributes to better training of a dentist.

REFERENCES

- [1] Shumilovich BR, Kosolapov VP, Rostovtsev VV. Development and preliminary assessment of the effectiveness of modern automated technologies for teaching manual skills in the specialty of dentistry. *Health and Education in the 21st Century*. 2016; 3 (18): 25-33.
- [2] Shumilovich BR, Gubin MA, Yelkova NL. The role of information technology in modern on-graduate dental education. *Materials of the scientific-practical conference of the employees of IDPO. Voronezh: The Scientific Book "Scientific Book"*. 2012; 47-53.
- [3] M.Gorshkov. The history of simulation training in Russia and abroad. *Medical Education and Professional Development*. 2012; 3: 126-127.
- [4] Naigovzina NB, Filatov VB, Gorshkov M.\D. All-Russian system of simulation training, testing and attestation in healthcare. *Virtual technology in medicine*. 2013; 1 (9): 8-24.
- [5] Nikolaev A.I. Phantom course of therapeutic dentistry M.: Medpressinform, 2009; 239 .
- [6] Kubyskin VA Virtual technologies in medicine. *Scientific and Practical Journal*. 2009; 1 (1): 3-9.
- [7] Ahlberg G, Enochsson L, Gallagher AG, Hedman L, Hogman C, McClusky DA III et al. Error rate for residents during their first 10 laparoscopic cholecystec-tomies. *Am J Surg* 2007; 193: 797-804.
- [8] Larsen CR, Soerensen JL, Grantcharov TP, Dalsgaard T, Schouenborg L, Ottosen C, Schroeder TV, Otesen BS. Effect of virtual reality training on laparoscopic surgery: randomized controlled tial // *BMJ*.-2009; 338: 1802-1809.
- [9] The effect of hi-fi simulation on educational outcomes / Rodgers DL, et. at. // *Simulation in Healthcare*. - 2009. - №4. - P. 200-206.
- [10] Gaba DM. The future vision of simulation in health care. *Quality and Safe-ty in Health Care* 2004; 13 (suppl1): i2-i10.
- [11] Alinier G. A typology of educationally focused medical simulation tools // *Med. Teach*. 2007; 8 (29): 243-250.
- [12] Khamatkhanova EM, Marchuk NP, Degtyarev DN. The role of simulation-training technologies in the training of medical personnel for perinatal centers. *Neonatology: news, opinions, training*. 2014; 1 (3): 91-94.
- [13] Shumilovich BR, Spivakova IA. Modern automated technologies in the kur-se simulating professional education in the specialty "dentistry". *Institute of Stomatology*. 2014; 1 (62): 28-30.
- [14] Shumilovich BR, Rostovtsev VV. Modern Information Technologies as an Effective Method for Teaching Students and Patients in Dental Clinical Practice. *The System analysis and management in biomedical systems*. 2015; 4 (14): 801-804.



- [15] Shumilovich BR, Spivakova IA, Rostovtsev VV. A method for assessing the survival of acquired practical skills in the preparation of hard tooth tissues. Limited Liability Company is a small innovative enterprise "The Art of Dentistry" (RU); claimed. 10/16/2014; publ. 03/27/2016, bul. №9.