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DEVELOPMENT OF THE TECHNIQUES OF TRAINING OF PROFESSIONAL SKILLS OF DENTAL STUDENTS

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Abstract

The problem of acquisition of practical skills of dental students always had significant part in their educational programs. As direct patient treatment is quite complicated for dental students due to ethical concerns the various simulation techniques and devices have been developed. Using of them allows trainees to practice typical and most necessary manipulations before they meet patient at the first time in clinic. The development different spheres of medicine and science allows to create more helpful techniques for training of professional skills of students also with the involving of new innovations and technologies alike virtual reality.

Key words: *practical skills, dental students, VR, simulation techniques, phantom model.*

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Abbreviations

AR – augmented reality
IDEA - Individual Dental Education Assistant
MR- mixed reality
OSCE - objective structured clinical examination
VR – virtual reality
The aim of this article is to evaluate current and future capacity of medical simulation technologies

INTRODUCTION:

Considerable efforts have been directed at examining the education methods for medical and dental students.

Today students have worldwide access to medical books, programs, articles, but it cannot be enough to improve their practical skills. For the beginning there is big problem for doctors how to develop their health professional knowledges, skills and attitudes and apply it to the patient, which safety is the aim purpose. Miller G.E. creates a framework for clinical assessment. There are four levels according Miller's Pyramid clinical competence:

1) knowledges: the individuals must have basis knowledges for performing skills;
2) competence: to know how knowledges are employed;
3) performance: learners need to demonstrate the skills;
4) action: learners perform independently and does this without someone else judging [1].

High requirements to doctors and the need to prepare them for the earliest possible date stimulate developing a new medical simulation technology. Medical students become active participants, this makes the educational process more interesting and motivating. Teachers could tailor to the needs of the learners.

The first simulator was used for cardiopulmonary resuscitation and until now it was well applied.

Since the time of introduction of educational devices in training procedures their design became more realistic with the achievements in manufacture technologies. First appliances used for educational purposes were natural human teeth. Then bench-top models of human jaws and phantom heads have come. These devices have been widely used for many decades and became gold standard for training of dental students [2].

Tanzawa *et al.* (2012) developed a full-body robot patient the major feature of which was possibility to simulate real patient's behavior including computer-controlled blinking of eyes, tongue and mouth movements (Figure 1). Simple "doctor-patient" conversation was possible due to the special software. Artificial saliva excretion from parotid gland has taken place to maximize resemblance. Moreover, the instructor was able to activate special regimes such as 'shaking neck', 'coughing', 'tongue thrusting' and 'mouth fatigue' to check trainee's skills of managing unexpected conditions during routine caries cavity preparation. Vomiting reflex triggers in the uvula were also available. Students were tested at objective structured clinical examination (OSCE) with this robot and afterwards shared their impression of it via questionnaire: 88% of them have marked that robot has been necessary in dental education and 95% have noted the increasing of the quality of training management and dental education compare to simple mannequin using [3].

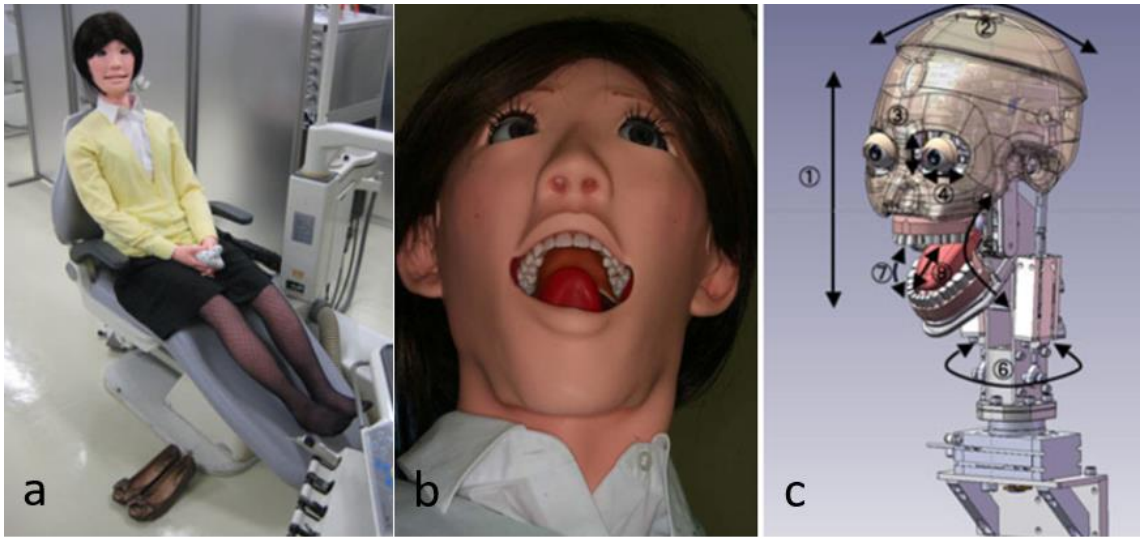

Figure 1. (a) General view of robot patient. (b) Close-up of the open mouth. (c) Available movements.

Unlike the tooth crown morphology it has always been difficult to model the anatomy of root canal system. Plastic endo training blocks which are currently available on the market, despite being

helpful in gaining basic haptic skills have a series of drawbacks: translucency of plastic, simplified geometric shapes of root canals, incoherence of tactile feelings when shaping a model canal with a real one are major disadvantages of existing models. Robberecht *et al.* (2017) designed a new method of overcoming them. Using of microCT helps to get thorough information about precise anatomy of root canal. The following step includes a creation of 3D computer model which is afterwards 3D-printed with acrylic resin. The obtained root canal mould is put into a plaster block (Figure 2a) and then hydroxyapatite slurry is poured over (Figure 2b). After setting the block is sintered to eliminate plastic mould (Figure 2c). Thus, the made ceramic simulator not only reconstructs the original anatomy of root canals but also mimics dentin hardness. Furthermore, its radiographs resemble those of natural teeth (fig.3), aiding to control root canal filling with gutta-percha [2].

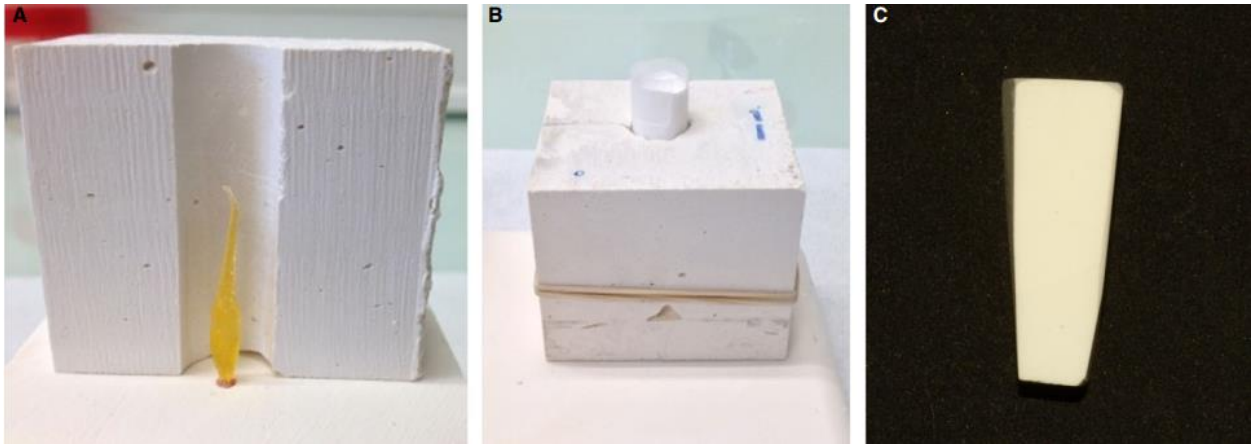

Figure 2. Fabrication of a root canal simulator

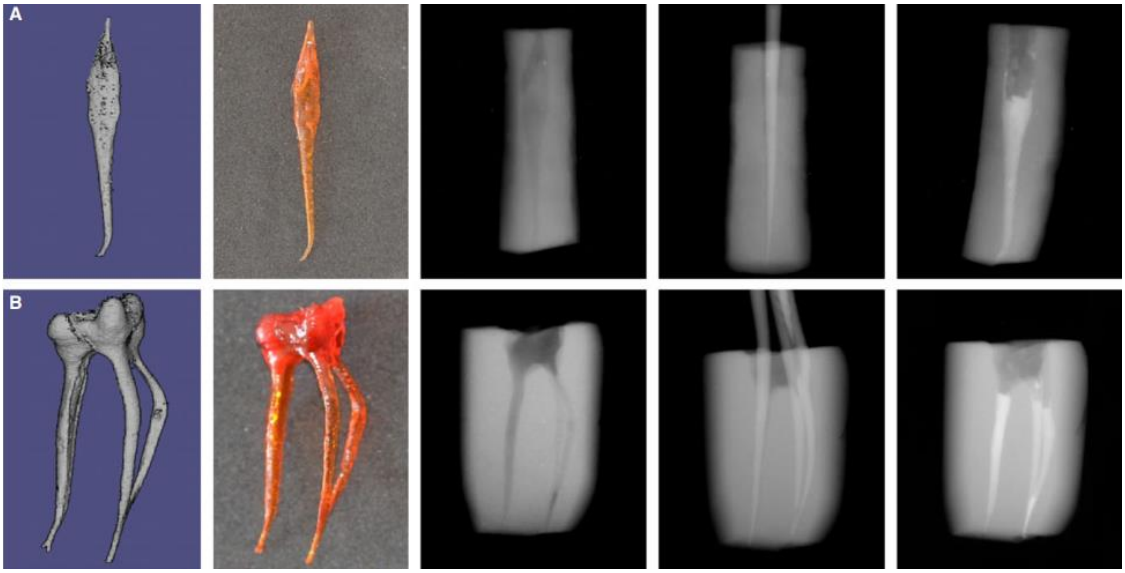

Figure 3. Simple (a) and complex (b) root canal system in ceramic simulator.

Gal *et al.* (2011) studied applications of Individual Dental Education Assistant (IDEA) simulator among students and dental educators. The system consists of a stylus attached to a stand providing haptic feedback (Figure 4a). The VR image is projected onto the computer monitor. In the study the trainees were required to perform several tasks including drilling in straight line, circle, wavy and rectangle shapes in

direct vision as well as in indirect vision using virtual dental mirror (Figure 4 b-d). The results have showed the positive effect on teaching manual skills although the major disadvantage of this simulator was absence of natural teeth virtual images as all the tasks were performed on the plain field. The participants also noticed realism of sensation (to drilling in a real tooth and to grip of a high-speed handpiece) to be of moderate extent (partially due to operating drilling through pressing a bottom not a foot pedal and lack of real fulcrum) what has shown the necessity of further development of software and hardware design to improve tactile sensations [5].

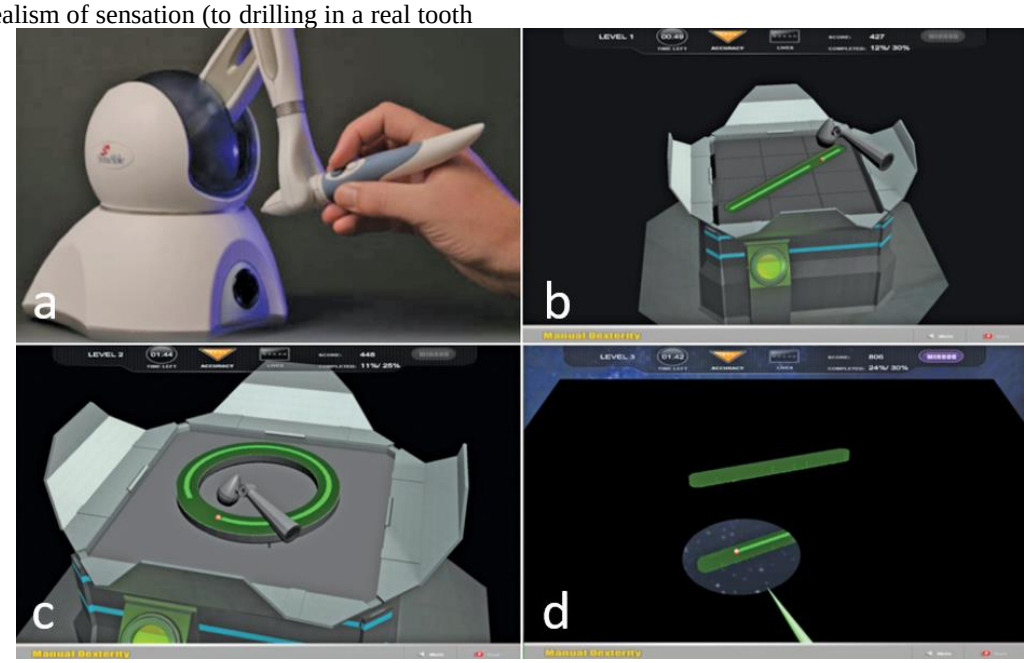

Figure 4. (a) Phantom handpiece stimulator. (b) Straight line task. (c) Circle task. (d) Straight line task using a virtual mirror.

Further development of virtual reality (VR) stimulators has led to manufacturing of the Simodont® dental trainer which offers close-to-reality 3D images seen through special glasses and mechanical feedback (Figure 5a). Bakr *et al*. (2015) in several studies evaluated its use by dental students to develop their manual skills. Possibility of choosing different hand instruments as well as high-speed and low-speed handpieces and burs has helped to increase the number of simulated cases, therefore leading to more comprehensive pre-clinical training (Figure 5b). Modern simulator technologies can replace traditional ones in the future [6].

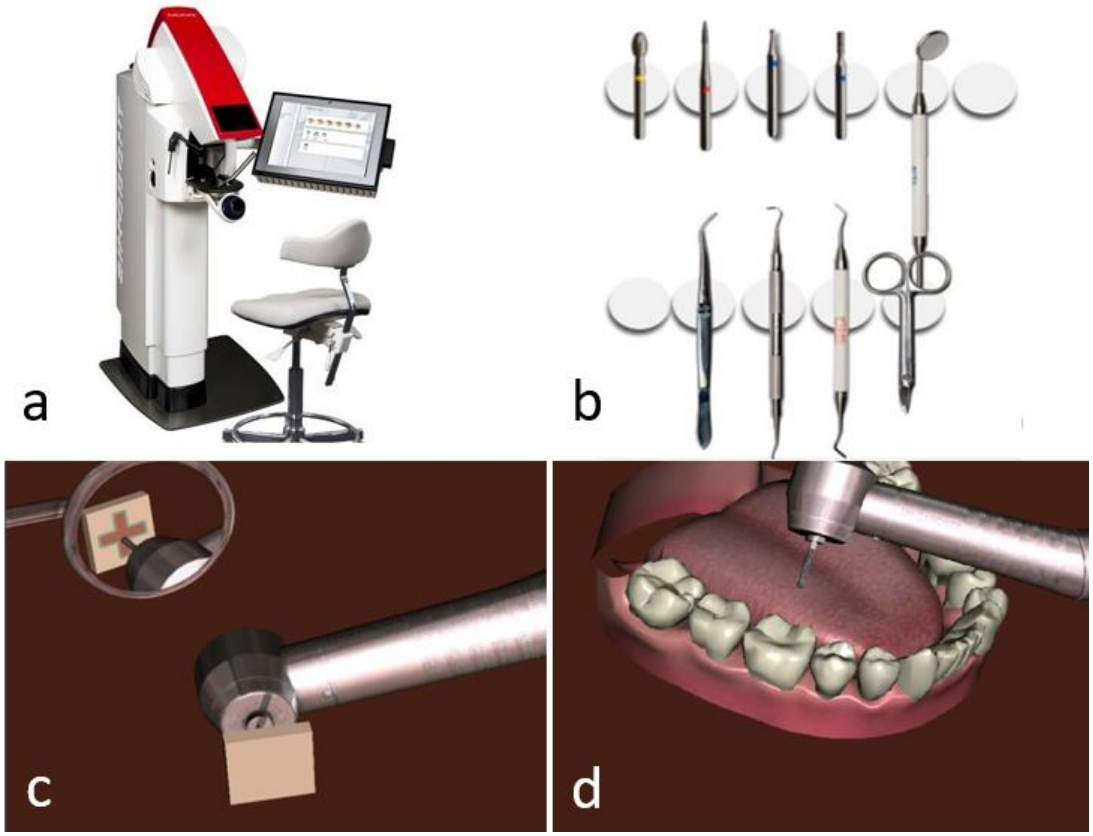

Figure 5. (a) Simodont® dental trainer. (b) Instruments tray. (c-d) Exercises.

VR, AR, and MR

One of the new methods to improve practice skills is to integrate VR reality in medical education. VR is a computer-generated program with the high-end user interface that involves a participant in real-time simulation.

Jaron Lanier coins the term "Virtual Reality" in 1989. NASA and space companies use it for remodeling of different spaceward conditions.

Virtual reality (VR) create a fully artificial environment and immersion a participant in the virtual environment without the direct contact of the educator. Augmented reality (AR) let overlaid virtual objects on real-world environment. Mixed reality (MR) combine virtual environment with the real world and let participant interact with both worlds. The essential difference between conventional simulation and virtual reality is that the VR is a computer-generated medical simulation of 3-dimensional images or environments. Not all procedures are suitable for training in a virtual reality because feeling and handling of teeth in virtual reality are not the same as it is in the real world.

For dentist, the main component is haptic simulations. Haptic let's feel objects using the senses of touch and proprioception.

In study Frank Quinn et al. (2003) compared the effectiveness of conventional training and virtual reality simulation. Junior dental students in groups performed repeated preparations for the lower left first molar. Group which used virtual reality in the training had the same (and sometimes worth) results in comparison with students with supervisor assessment. Student noticing VR advantages constant feedback, it allows self-paced learning. Researchers concluded that the combination of this methods provides the optimum outcome [7]. Students in the early stage of education need more detail explanation about hand and operator positions and movements. After 10 years in research Riki Gottlieb et al. which compare dental students' abilities using virtual reality simulation to those who did not use virtual reality simulation [8]. Researchers evaluate 5 factors: ergonomics, confidence level, performance, preparation, and self-assessment. Participants with VR were more successful than others.

In early-stage VR simulator can identify the students

with problems with the performance in operative dentistry.

S. Imber et al. (2003) found out that it can predict students with lower sensitivity and specificity [9].

D.X. Wan et al. [10] system simulated two dental operations probing and cutting. The goal of cutting in the simulation is a realistic resistance force between tool and tooth while maintaining the stability of the haptic device. The disadvantage of this system is that tools are limited to the use of spherical tools. The same problem Kim et al. [11] has with their device. It allows burring and drilling on the tooth and provide visual, audio, and haptic feedback. Periosim program permits to diagnose periodontal disease. The 3D model of the mouth is explored in real-time; the program allows doctors to adjust the model position, viewpoint, and transparency level while using a haptics device providing force-feedback to realistically interact with the 'virtual' mouth.

In the current moment, VR/AR/MR have several negative aspects: cost, pure content and limited program choice. Also, consequent health effects have not sufficiently explored.

According to the report of the consulting company Industry ARC, VR/AR reality market in medicine will reach 2.54$ million by the year 2020. Based on their research, specialists are focused now on two main directions: training for doctors and rehabilitation of patients.

The other biggest medical activity that gets only better with the help of VR is training for future specialists. As far back as 2014, Shafi Ahmed performed an operation to remove cancer by broadcasting the course of the operation in Google Glass for 13 000 students.

Such an experiment let the audience to observe the whole process with their own eyes in real time and even ask this doctor questions.

CONCLUSION:

The development of different techniques of training of students' skill allows to increase the quality of their education and professional management providing the creation of good basis manual practical features of the future doctors.

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