

Simulation Based Training in Dental Education- A Review

Kamakshi Raina, Dharnappa Poojary, Premalatha Shetty, Imran Khalid, Rashmi, K S, Chandana, Rekha D Kini, Vasavi R Gorantla

Article Info	Abstract
Article History Received: March 26, 2021 Accepted: May 18, 2021 Keywords : Dental Education, Simulation Techniques, Patient Safety DOI: 10.5281/zenodo.4770607	<i>Education in the field of dentistry, relies not only on academic or book based knowledge, but is also influenced by acquisition of a certain skill set by the students. This is the first step in becoming a good and sought after clinical practitioner. This literature review article discusses how the new age simulation techniques are transforming the field of dental education. It provides an overview of the various techniques used in accomplishing the same. The article gives a brief on select studies and/or reviews by renowned experts in the world of dentistry. There have been numerous researches and experiments which give us ample evidence of the benefits of simulation based training technology for dental students. The aim of this literature is to review the already existing research and review articles relating to the simulation technology used in the field of dental education. There has been a huge improvement in simulation techniques since the patient safety movement and shifting the main focus of dentistry on patient-centric healthcare. There are numerous methods that develop a structured condition which further enhances the process of development of skills. Some of these methods include simulation activities, role play, part task trainers and immersive simulation. Some of these modalities are discussed in this article.</i>

Introduction

Simulation is the imitation of operation of a real world process or system over a period of time. By definition, a situation in which a particular set of conditions is created artificially in order to study or experience something that could exist in reality.¹ In the field of dental education, a set of specific requisite skills can be taught by acquiring the necessary psychomotor skills before applying the same in a real world scenario on living patients. The transition of the learning process, from a traditional model-based technique to entering the clinical practice, has been smoothed with the help of the new age simulation technology. We are witnessing a change or update in technology with each passing day. The primary goal of dental education and clinical training should be imparting education, keeping in mind the safety and well-being of the patients. With the help of contemporary simulation methods, one can achieve significantly better results while working with patient-centric healthcare. The concept of dental simulation first came into being, when Oswald Fergus designed the first dental simulator in the world, namely, The 'Phantom Head' in the year 1894.² According to the Health Workforce Australia, 2010, dental students use simulation techniques for acquisition of basic skills in preclinical setup like cavity preparations, crown cutting procedures, debridement of calculus and removal of plaque. Sometimes application of pit and fissure sealants or fluoride application in case of pediatric patients can also be done using simulation technique prior to clinical work. Over the last few years, there has been 'deliberate practice' of simulation modalities for training, overall education and assessment of students in general.³

2.PHASES - IN THE PROCESS OF SIMULATION BASED LEARNING

According to 'A scoping review of simulation based dental education' by Dr. Denise Higgins, the training of aspiring dentists using simulation based technology can be done in phases. These phases include briefing, simulation, feedback, debriefing, reflection and evaluation. Each of the above mentioned phases are interdependent. As per the phases, at the beginning of the simulation procedure, the students are briefed about the entire activity in detail so that they are prepared for the simulation based learning experience. All the important information regarding the procedure as well as the outcomes are explained to the students. The simulation activity is then conducted along the same lines as what was explained to the students. A feedback is received and noted, following which, a post activity debriefing is given to the students and a subjective evaluation of the entire process is done. This forms a complete cycle. Such sessions can be very efficient, if custom designed or with slight alteration in an existing technique, to test the competency of dental students in a clinical environment. All the mentioned phases should be followed in order to complete the learning loop.⁴

3. PROS AND CONS OF NEW-AGE SIMULATION TECHNOLOGIES

Everything in the sphere of life has its advantages and disadvantages.⁵ Simulation allows the dental students to apply and practice their theoretical knowledge acquired by them in the classroom. The students can understand abstract dental concepts, which they otherwise would find confusing while either reading or learning during lectures. There have been numerous studies which prove the time taken to acquire a particular skill significantly decreases when a real life situation is simulated. The students can learn the necessary skills at their own pace rather than being rushed in a crowded hospital setting. Simulation based training, given prior to actual performance, boosts the confidence of the students and enables them to work better in a clinical scenario. Simulation procedures can be modified according to the training process. Students can be trained how to efficiently handle rare or unusual cases which are otherwise hard to train for, so that they are not caught off guard whenever such cases present themselves in real life. One of the most important aspects of healthcare is patient safety. Simulation based procedures provide a safe, hassle-free environment for learning and do not expose the dental patients to any sort of risks by inexperienced students. The training provided using these methods can be in a properly planned way rather than relying on random cases of a clinical setup. It can also be used as a standardized training tool for all students. The students can perform the same procedure multiple times, thus perfecting their skills to a significant degree. These simulation procedures can be customized for assessment of students and the results can be analyzed by the trainers or the staff members for a better learning environment.

Some major disadvantages of the widely used simulation based training methods is the high initial set-up and maintenance cost. The faculty has to be trained in the intricacies of the simulation procedures, before they can teach the students. This requires a huge amount of time, infrastructure and capital. These modalities, no matter how life-like, cannot mimic the very complex human body in its entirety. They lack multiple natural features. Salivation, movement of tongue by the patient, reaction of the patient towards pain, etc. are some of these factors.

Poorly designed simulators can promote defective learning instead of equipping the students with the necessary skills.

4. SIMULATION BASED TECHNIQUES - INDIAN SCENARIO

The reforms in curriculum to incorporate simulation based learning techniques are primarily based on globalization and international subsidies.⁶ Various new simulation techniques are being introduced to the dental students along with the traditional phantom heads used in preclinical training. Some of the new techniques like virtual reality, haptics technology like the MOOG Simodont Dental Trainer, DentSim are being incorporated at a very fast rate in the dental curriculum. Manipal College of Dental Sciences (MCODS), Mangalore, Manipal Academy of Higher Education, MAHE, Manipal, Karnataka, India, is one of the pioneers in the introduction of simulation based techniques in the regular preclinical curriculum. A special “Pre-Clinical Skills Lab” has been installed with the latest simulation equipment and mannequins.



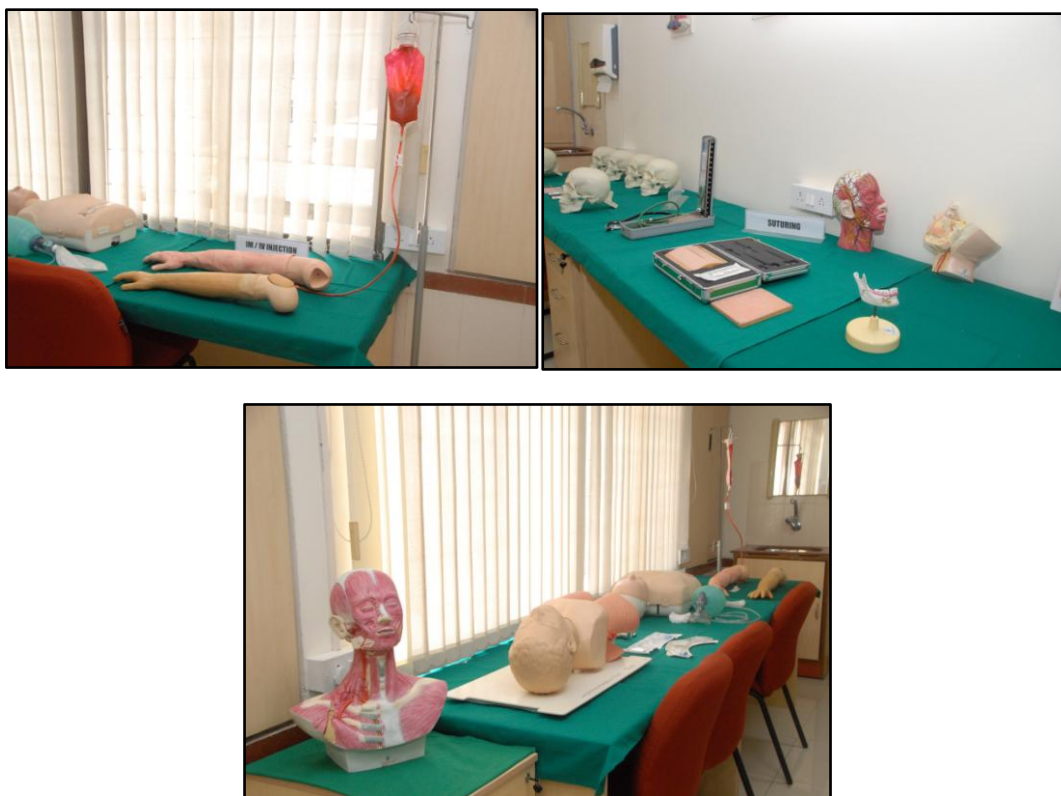


Fig 1: Highly sophisticated labs used for training of Dental students - Manipal College of Dental Sciences (MCODS), Mangalore, MAHE, Manipal, Karnataka, India

A variety of procedures can be simulated in this highly sophisticated lab. The types of sutures that can be given in the oral mucosa, the exact anatomical landmark for an intra-alveolar nerve block injection and other nerve blocks and infiltration anesthesia, are some of the procedures that can be easily simulated in the preclinical training for dental students. This helps to build the necessary confidence and skills to perform the procedure in a similar clinical environment.



Fig 2: Technique of Suturing - Manipal College of Dental Sciences (MCODS), Mangalore, MAHE, Manipal, Karnataka, India

In this photograph, a trained professor can be seen teaching the proper technique of administration of Infra Alveolar Nerve Block on the mannequin patient.

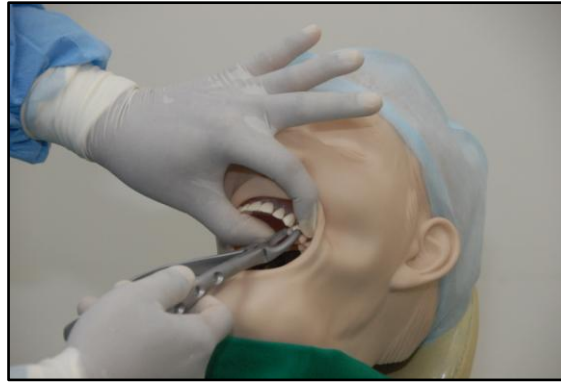


Fig 3: Technique of Exodontia - Manipal College of Dental Sciences (MCODS), Mangalore, MAHE, Manipal, Karnataka, India

The above photograph shows, a trained professor can be seen teaching the students the correct technique of exodontia. The cheek and lips can be retracted in this new-age mannequin to give a better simulation of the real life patients in clinical settings.

The training in such environments offers additional benefits of enhanced performance and help in reducing the errors. Similar simulation based training centers have been set up in multiple universities including Amrita Vishwa Vidyapeetham and other enterprises like Dr. A.P.J. Abdul Kalam Education & Research Centre and Superspeciality Dental Clinic.^{7,8}

5. METHODS OF SIMULATION BASED LEARNING IN DENTISTRY

5.1. Standardized Patients

The approach of using standardized patients in a preclinical environment has been used in the field of dental education since the 1970s. In times of relationship-based care, dental students can take a thorough dental and medical history and perform intra oral as well as extra oral examination. This enables them to keep an accurate record of the patients and also assists in the correct diagnosis of the patient condition and making the treatment plan to be followed for the same. The students can also learn how to communicate with real patients and develop good interpersonal skills. This interaction can help them to familiarize themselves with patient issues and incorporate the personal issues of the patients into the treatment plan.⁹

The disadvantages of using such an approach includes the unavailability of such standardized patients in medical or dental schools. The monetary capital required may also be a factor for this method to become unpopular in the education field.

5.2. Traditional Phantom Head Simulation

Scientific literature reveals that, the concept of dental simulation first came into being, when Oswald Fergus designed the first dental simulator in the world, namely, The 'Phantom Head' in the year 1894.¹⁰

The 'Phantom Head' is a functional cephalic model along with an arrangement of typhodont teeth. It is a widely used simulation method in dental schools across India and also overseas. It provides partial experience to students of a clinical scenario. The phantom heads are widely used in learning proper techniques of cavity preparation, tooth isolation using rubber dams and crown cutting procedures in restorative dentistry and prosthodontics. The cost of installing phantom heads is lower than other advanced simulation technologies.

5.3. Virtual Reality Based Simulation Technology

Virtual reality (VR) typically refers to computer technologies that use a software to generate the realistic images, sounds and other sensations that replicate a real environment (or create an imaginary setting) and simulate a user's physical presence in this environment.¹¹ The recent advances in computer simulation and imaging technologies have enabled dentists to get highly accurate, high definition images of the teeth and other oral structures. It enables students to receive accurate, immediate, 3-D, audio and written feedback of the virtually conducted procedure. Virtual reality based technology (VRBT) can be used both in dental and medical procedures to reduce the risk to patients and improve the efficiency of the healthcare provider.

DentSim is an augmented reality advanced dental training simulator.¹¹ Optical tracking and analysis of the artificial typhodont and the hand-piece is done in real time. The unit required for DentSim, comprises a dental handpiece with water spray, an air/water syringe, a low volume suction, foot control, overhead light, simulated patient/mannequin, infrared camera, and a computer. The LEDs present in the handpiece and the simulator's jaw emit infrared signals to the camera placed above. The computer can therefore assess their orientation with respect to each other and calculate the distance between the dental bur and the tooth. The information is then displayed as a 3-D tooth image on the screen. Using this technology, one can keep the record of progress made by the students and get an accurate feedback of the simulation activity.

➤ **Haptic Technology**

The term 'haptic' is derived from the Greek word 'haptēn' which means 'to fasten'. Haptic technology in association with virtual reality technology, provides users to interact with virtual objects by touch (tactile sensation) and proprioception.¹² A dental simulator using a haptic interface, provides a force feedback of the procedure from the virtual model. This technology enables students to learn and practice in an almost identical environment to the real life clinics as opposed to widely used artificial plastic teeth. Several softwares like the MOOG Simodont Dental Trainer assists the students in acquiring the requisite skills by a combination of virtual reality softwares, haptic technology, visual and audio sensory information.

5.4. Robotic Technology

The term robotics was introduced by writer Isaac Asimov in his science fiction book, *I Robot*, published in 1950.¹³ According to the Oxford dictionary, Robotics is the branch of technology that deals with the design, construction, operation and application of robots as well as computer systems for their control, sensory feedback, and information processing.¹⁴

With new advancements in robotic technology, robots can be used to train dental students in the fields of surgery, endodontics, implantology, orthodontia and prosthodontics. Robot patients can be used as an adjunct to real life patients in order to reduce error by the operator and improve efficiency in a dental procedure. New age robots have multiple features that mimic the real patients like the blinking of eyelids, gag reflex, coughing, etc. These are controlled by the trained professional overseeing the simulation procedure. Some examples of the robotic patients are Showa Hanako, Geminoid DK, endo-micro robots, dental nano-robots, surgical robots.¹⁵

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Author Information

Kamakshi Raina

Postgraduate, Manipal College of Dental Sciences,
Manipal, Manipal Academy of Higher Education,
Manipal, Karnataka, India

Dharnappa Poojary

Dept of Oral and Maxillofacial Surgery, Manipal
College of Dental Sciences, Mangalore, Manipal
Academy of Higher Education, Manipal, , Karnataka,
India

Premalatha Shetty

Dept of Oral and Maxillofacial Surgery, Manipal
College of Dental Sciences, Mangalore, Manipal
Academy of Higher Education, Manipal, ,
Karnataka, India

Imran Khalid

Dept. of Oral and Maxillofacial surgery, King Khalid
University College of Dentistry, Abha KSA

Rashmi K S

Dept. of Physiology, Kasturba Medical College,
Mangalore, Manipal Academy of Higher Education,
Manipal, Karnataka, India

Chandana

Dept of Anatomy American University of Antigua,
College of Medicine, Antigua, West Indies

Rekha D Kini

Dept. of Physiology, Kasturba Medical College,
Mangalore, Manipal Academy of Higher Education,
Manipal, Karnataka, India

Vasavi R Gorantla

Dept of Anatomical Sciences, St Georges's
University, Grenada, West Indies.
