Skill and Simulation Lab in Dentistry - A Futuristic Era

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Abstract

Simulation is a technique where the situation or a process is imitated. This process makes one to pretend the scenario. Aviation industry is one of the oldest industry which uses simulation technique to simulate the aviation technique. The main aim of having simulation lab is to make students acquire psychomotor skills before they actually treat the patients. Presently the National Medical Council of India has made it mandatory to have a skill lab but desirable to have a simulated mannequin for the training of medical students before actually treating the patients. Various advantages and disadvantages are appreciated in simulation technique. It is not very far that Dental council of India may make compulsory training of certain simulated modules in dentistry before treating the patient. Simulation lab in the pandemic like COVID has really helped people to undergo extensive training before treating patients, especially one who were catering the COVID ward or intensive care units. The simulation in dentistry is not a very old technique, certain technique are already in practice, but this article tries to highlight the necessity and gray areas where simulation can be improved for the benefit of students to learn and for the benefit of patients in view of safety.

Keywords: Dentistry, Debriefing, DCI, NMC, Skill, Simulation.

INTRODUCTION

Dental simulation is not a very new concept in the dentistry. The first “phantom head” was in use by the late 19th century. The VR and computer software based simulation were introduced in late 1990s and early 2000s. With the advancement in time, the technology has evolved to three dimensional virtual reality. Various software based dental simulation technique for teaching were developed and became very popular. The main goal is to facilitate learning strategies in effective, cognitive and psychomotor disciplines. It is very ideal to train the students first on simulation based scenarios instead directly allowing them for treating the patient. Thus pre-patient skill and simulation training helps dental students to understand better and will have a good transition to handle clinics. Dentists are trained for most of the head and neck areas and not just oral health. It is very important to highlight here that they are the expert to treat head and neck area which is rich in vasculature and having various major vessels. The skill and simulation lab of dentistry can be used to teach the students in relevant pharmacology, anatomy, biology, and emergency treatment. Dental skill and simulation training will help preclinical education and ensures patient safety. One of the biggest advantages of having dental skill and simulation lab is the clinical practice training is reversible, repeatable as many times as required, and more realistic and environment friendly. The dental skill and simulation lab boosts the confidence of the student to perform any procedure and ensures patient will get maximum care. In this article authors tried to emphasize the importance of skill and simulation lab and important major requirements that should be kept in mind while building it.
Basic skill and simulation lab:

In most of the basic dental skill and simulation lab has a phantom head and consists of a 360 degree dome skull with a complete oral cavity. The dental instruments like light source, suctioning, hand pieces, water spray and other tools can be incorporated so that the students can actually feel that the work is done on a patient. Some of the mannequin have haptic models paired with a computer screen so that the operator can understand the mistakes if any and correct it real time. Here the artificial plastic or extracted teeth are kept for the practice of certain procedures. Various other task trainers like suturing pads, knot practicing equipment, basic life support training mannequin, tooth extracting trainer can be the part of it.

Advanced skill and simulation lab:

Here in this lab all the facilities of basic skills and simulation should be the part of it. The technology like virtual reality like VR goggles, computer generated 3D images should be utilized. The VR glass can help in understanding the anatomy of the head and neck regions. One can use fingers to touch the images and dissect the part and understand the anatomy without going to dissection hall. The VR technology has advantage that it will not consume lot of space for the simulation as the goggle itself is very compact, clarity of every minute part can be made based on the software incorporation, a detailed explanation can be incorporated side by side of the virtual image. This technology can be used for unlimited period and for unlimited people. The VR technology is not free from the disadvantages as it will make the student to appreciate the touch of tissue. In future one may expect such technology for understanding head and neck parts which includes the details of skin and its layers, muscles, bones and neurovascular structure. The goggles will be quite bulky and may make uncomfortable for some. This is not untrue that certain people may face anxiety, claustrophobic, nausea strain to eyes etc. while using it.

PerioSim:

It is a simulator which helps the students to acquire the sensorimotor skill in periodontal treatment. The interesting feature of the simulator is that it has the ability to generate templates of position and force trajectories for the students to follow. This simulator also has a mechanism of haptic playback which helps the students to understand their mistakes. In this, the teacher can also perform a procedure and record it. The trainee will be able to observe the recorded procedure and follow it. The simulator can help the student to feel tactile sensation and is very realistic for teeth and gingiva.

Debriefing technique:

Debriefing is one of the critical steps in the simulation training and is considered by many simulation trainers. Here, conversation between trainer and participants happens and will reflect and give feedback to improve the future performance. One of the added advantages is deep learning can be achieved during debriefing but entirely depends on the facilitation skills of the debriefer that is trainer. It serves as a powerful tool and a robust educational technique in dental education. The use of debriefing technique in simulation programs has enhanced team performance and improved behavioral and technical skills. Thus the use of debriefing following clinical events not only improves the skills and behavior of the participants but also the patient care. Poorly facilitated debriefings may lead to create adverse learning, harm the relation between educator and participants, may create lack of confidence among participated students, it may also lead to degradation of clinical performance, self-reflection. Multiphase or three phase debriefing technique can be followed for effective outcome of the simulation.

3D printed models for dental simulation:

This is a new concept where we can take a 3 dimensional print of the required part of head and neck. Here the models are prepared based on the real patients and thus providing students a more realistic approach for real case scenarios. The data is acquired by 3D surface scanning and further processed with 3D modeling software to create models of 3D print with the PolyJet technique. Various interdepartmental case discussions with treatment plan can be practiced easily. Traumatic dental injuries is not uncommon in India as road traffic accidents are very common. While teaching dental traumatology 3D printed tooth can be used for simulation purposes to the train the students.

Virtual Reality Simulation in Periodontology:

Pocket probing depth (PPD) and gingival bleeding and important parameters for diagnosing the disease which ultimately depends on the skill of a dentist. A haptic virtual reality simulator system (PerioSim) was introduced by Steinberg et al. in 2007. PerioSim® introduced “touch to feel” sensation. It has stylus to use with physical models which in turn depict visually
in 3D. The result of the said study showed that tactile perception of increased remarkably. Yamaguchi et al. also put forward a haptic feedback virtual reality system which was designed for periodontology especially.11 This system consisted of simulation of pocket probing and caries removal. Even this system was found to increase the tactile perception of students but 100% replication of clinical setting was not present. The major advantage in all he studies previously stated was remarkable improvement in tactile perception and potential to appreciate the anatomical considerations. The biggest advantage of VR system is the less time consuming compared to conventional learning. The drawbacks of all VR system are its hefty cost of devices and still the accuracy is not up to the mark. So its use is still a questionable in developing countries like India.

Virtual Reality Simulation in Conservative Dentistry:

The traditional training uses manikins to help in positioning and mimicking the anatomy of tooth structure. Conventional manikins are unable to mimic the mechanical properties of natural teeth. This leads to emergence of computer assisted simulations for undergraduate training.12 Virtual reality (VR) in conservative dentistry and endodontics provide the digital environment for the users to carry out different procedures like cavity preparation, caries excavation and light curing procedure.13 The added feature of simulation fidelity provided the learning objectives. This feature allowed to practice their exercises independently and provided them with standardized assessment of their work. This device has a facility of recoding of individual sessions also. Quinn et al. compared conventional training with virtual reality simulation among dental students for outline of cavity, depth of cavity, fineness of cavity preparation, retention form and angulation of margins.14 Performance of students trained with VR simulators was better compared to conventional training. On the contrary the results of retention form and angulation of margin were same in both the groups. Jasinevicius et al. in another novel study concluded that students can be trained five times more promptly in contrast to traditional exercising.15 Therefore, VR simulation based training should be incorporated in the curriculum as this provide self-learning to the students and also help in improving the skills and transferring the skills into clinical practice. The study by Jonathan et al. on commercially available VR device VIRTEASY Dental© provide the detailed assessment proof of solidity and clinical relevance of restorative procedures.16

Virtual Reality Simulation for Prosthodontics:

Most of the prosthetic procedures are complex and require perfection. Therefore for undergraduate students such clinical situations can be created digitally. This will boost their confidence in clinical skills. Virtual reality simulators, IDEA for removal of bridge or DentSim™ ® for different crown and bridge exercises in experimental studies have shown better results in scores of students.17,18 With the help of VRS the students can have their work record and their progress as well. The best advantage of such simulator is that it provides alarming sounds if the user does a mistake in any procedure. This feature will benefit the students and teacher both. Fenney et al. proposed that virtual reality simulation in dental education grew student’s keen interest in practical.19 Esser et al. studied the hurdles in traditional training programs for undergraduate students and he highlighted the VRS should be introduced in undergraduate training.20

Virtual Reality in Oral and Maxillofacial Surgery:

The haptic devices used in the VRS allows its users to detect the texture of the surrounding soft tissues or bone handling drill, consequently preparing them for real case scenarios.21 Plenty of methods have been put forward to motivate the dental students for self-learning. This way the faculty time is reduced and enhances their clinical skills also. VOXEL-MAN® simulator is one of such simulator which is user friendly, self-learning device, low cost, skill refining.
The content of simulation lab:

Infrastructure:

Presently most of the labs are labeled a skill and simulation lab. Since even in simulation lab skill is also integrated this can be justified. The infrastructure of the skill and simulation lab should be considered as an important thing for developing it. Based on the number of students who will get trained the area can be identified. It is ideal to have at least 4000 square meter area for 100 students. The entire area can be split into skill (using task trainers) and simulation (using high fidelity mannequins). Every skill station should have separate cubicles and should accommodate at least one teaching faculty and ten students. More than ten students are not advisable as it will create the noise. There should be a sufficient area for simulation part, where one can place the required simulating material. In case of dentistry the dental chair, simulating mannequin, phantom head etc, should be made available. One should not forget to have console room which will have a one way visualization glass with adequate space for the person managing simulation of high fidelity mannequin. A proper light source, suction, hand wash area, emergency cart, monitoring system, drainage, adequate storage should be considered. Both the skill and simulation area should have good audio visual facility, debriefing area, completely a noise free zone, air-conditioned, adequate light, internet facility and telecommunication. There should be a camera which can record both video and audio in the simulated area. The skill and simulation lab should be backed up with adequate storage facility and should be rodent and dust free zone. The lab should have adequate hand wash, drinking water and toilet facility. It is ideal to have a changing room and separate footwear should be considered for the people who are entering the lab. There should be a faculty preparation room wherein the faculty will prepare the presentation or simulation protocol if any. The preparation room for wet lab or any mannequin requiring liquid containing material for preparation like simulating blood etc, should have drainage facility. The space should be adequate enough to accommodate at least 3 to 5 faculties at any given point of time for 100 students. It is ideal to have a meeting hall with audio and visual facilities which will help for conducting meetings. One dedicated room should be given for the biomedical department for the maintenance and preparation of simulation or skills. Although majority of procedures are carried out at dental clinic level, certain procedures like head and neck cancers, pediatric dental treatment may require operation theatre. To train the techniques practiced in operation theatre one should consider adequate space for changing rooms and dedicated hand washing area just like any operation theatre.

Manpower:

The skill and simulation should have a dedicated team of teaching faculty who should have experience of conducting simulation. There should be a record keeper and should have coordinated timetable. The record keeping person should ideally take pretest, posttest and feedback from the participants. A dedicated biomedical team who has undergone training in handling mannequin and or the biomedical equipment should be made available. The faculty, biomedical team and the person handling the console room should coordinate with the faculty so that the scenario is successfully conducted. Adequate sanitary staff should be made available for the routine maintenance of the lab.
Safety:

The ideal skill and simulation will have heavy investment and the entire mannequins are mostly sensitive for the heat, rodents and water. One should ensure fire safety protocol is followed meticulously. An emergency exit is must in lab area. Whole area should be under CCTV surveillance and the complete zone should be dust and rodent free.

Procedures which can be carried out in dental skill and simulation lab:

Various procedures can be considered in skill and simulation lab. Following are the minimum procedures that can be considered but not limited to. (Table 1)

<table>
<thead>
<tr>
<th>S.N</th>
<th>Procedure name</th>
<th>Skill/simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic suturing technique</td>
<td>Skill</td>
</tr>
<tr>
<td>2</td>
<td>Advanced suturing technique</td>
<td>Skill</td>
</tr>
<tr>
<td>3</td>
<td>Injection techniques (intramuscular, intravenous, subcutaneous, intradermal)</td>
<td>Skill</td>
</tr>
<tr>
<td>4</td>
<td>Nebulization technique</td>
<td>Skill</td>
</tr>
<tr>
<td>5</td>
<td>Basic and advanced life support</td>
<td>Skill and simulation</td>
</tr>
<tr>
<td>6</td>
<td>Root canal treatment</td>
<td>Skill</td>
</tr>
<tr>
<td>7</td>
<td>Traumatic conditions</td>
<td>Simulation</td>
</tr>
<tr>
<td>8</td>
<td>Flap surgeries</td>
<td>Skill</td>
</tr>
<tr>
<td>9</td>
<td>Asthma</td>
<td>Simulation</td>
</tr>
<tr>
<td>10</td>
<td>Allergic reactions</td>
<td>Simulation</td>
</tr>
<tr>
<td>11</td>
<td>Hypoglycemic condition</td>
<td>Simulation</td>
</tr>
<tr>
<td>12</td>
<td>Scaling</td>
<td>Skill</td>
</tr>
<tr>
<td>13</td>
<td>Plating</td>
<td>Skill and simulation</td>
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<tr>
<td>14</td>
<td>Hypo and hypertension during procedure</td>
<td>Simulation</td>
</tr>
<tr>
<td>15</td>
<td>Giddiness during procedure</td>
<td>Simulation</td>
</tr>
<tr>
<td>16</td>
<td>Bleeding and its management</td>
<td>Skill and simulation</td>
</tr>
</tbody>
</table>

Wet skill and simulation lab:

Although the skill and simulation lab provides near real materials unfortunately one may not experience the touch of tissues. In this lab either the animal or fresh cadaveric tissue can be utilized to learn and practice various techniques. Techniques like incision, suturing, flap surgeries, simulation of bony fractures and its treatment like reduction of fracture segments or plating can be taught and practiced. The wet skill and simulation lab can be the part of advanced simulation lab.
There should be an authenticity of the skill and simulation training. Thus it is important that along with the training the post training assessment should be mandatory. Exit exam should be considered after the training of students in skill and simulation lab. Minimum and maximum allotted marks should be mentioned and if exam is cleared a certificate should be issued to the students stating that he or she is fit to treat patients.

Accreditation of skill and simulation lab:

A good number of skill labs are present all over the country. There is no fixed format or guidelines for the development of skill and simulation lab. The governing bodies should provide minimum required area and the facilities that should be made mandatory in the dental college. To promote and to maintain the standards of skill and simulation lab the government should have a separate body to assess the skill labs and give accreditation.

Conclusion:

The dental college must have mandatory incorporation of skill and simulation lab by the regulatory bodies as a part of training which will help to produce dental practitioners with good clinical skills. The skill and simulation lab helps students and faculties to communicate better and thus making them competent experts. Various studies have shown the implementation of latest technology like VR and haptic simulation tutors have improved psychomotor skills of students.

REFERENCES