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RESEARCH ARTICLE

# High-Fidelity Simulation in Dental Treatment under General Anesthesia: An Interventional Study

Fatimaazzahra El Mouatarif[1,*], Zineb Bennour[1], Zineb Al Jalil[2], Mohammed Chahbouni[3], Mohammed Mouhaoui[4], and Samira Elarabi[5]

## ABSTRACT

***Background:*** **Traditional lecturing has been the most frequently used method for teaching Dental Treatment under General Anesthesia for years. However, it been criticized for its limited effectiveness in achieving students' learning outcomes. Simulation-based training offers dental students a 'real' hands-on experience in a safe and effective learning environment.**

**The aim of this study was to assess the impact of simulation in the process of learning dental treatment under general anesthesia.**

***Design:*** **Simulation sessions of dental care under general anesthesia were organized for 33 post graduate dental students. The effectiveness of the simulation sessions was measured by comparing the level of knowledge of the group exposed to simulation with that of the students who were not. Student satisfaction was measured by means of a questionnaire administered at the end of the session.**

***Conclusion:*** **For the exposed group, the average score was significantly higher after simulation ($p < 0.001$). The difference in the average scores of the two groups was significant ($P = 0.024$).**

**This study confirm that simulation-based training may offer excellent opportunities for learners to increase patient safety, improve their clinical competence and confidence Integrating simulations into dental curricula is necessary in order to provide students with the opportunity to practice safe dental care in a safe and realistic learning environment.**

**Keywords:** Dental care, dental student, general anesthesia, medical simulation.

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[1] *Pediatric Dentistry Department, Faculty of Dentistry, Mohammed VI University of Health Sciences (UM6SS), Morocco.*
[2] *Pediatric Dentistry Department, and Laboratory of Community Health, Epidemiology and Bio-Statistics, Faculty of Dental Medicine, Hassan 2nd University, Morocco.*
[3] *International Medical Simulation Center–Mohammed VI University of Health Sciences, Morocco*
[4] *Faculty of Medicine, Hassan 2nd University, Morocco.*
[5] *Head of Department of Pediatric Dentistry, Faculty of Dental Medicine, Hassan 2nd University, Morocco.*

* ***Corresponding Author:***
e-mail: fz.elmouatarif@gmail.com

## 1. Introduction

Traditional lecturing has been the dominant teaching method in dental education for years. It is based on the assumption that the information is transferred from teachers to students to provide students with a predetermined body of knowledge. However, this belief is no longer appropriate and effective in meeting the needs of today's classrooms. Lecturing has been criticized for its limited effectiveness in achieving students' learning outcomes. To equip dental students with a certain amount of knowledge and clinical skills to prepare them for independent practice, teachers are now encouraged to adopt more interactive learning approaches, where students' autonomy is promoted and problem-solving and critical thinking skills are acquired. They must receive ample patient exposure to improve dental students' clinical skills. This can only be achieved through simulation-based training (Higgins *et al.*, 2020; Roy *et al.*, 2017).

In recent years, simulation has gained widespread recognition in dental education. This approach seeks to produce clinical situations by incorporating simulated patients into real clinical environments. It provides dental students valuable hands-on experience to develop and enhance their clinical dental skills while guaranteeing patient safety.

The benefits of simulation should be reevaluated, considering the lack of patient communication and relationship management. Instead, the focus should be placed on the main advantages of integrating simulation in dental practice (El Oury *et al.*, 2021; Perry *et al.*, 2015). Concepts or procedures can be simulated several times before being

performed on real patients. Due to the judicialization and mediation of medical complications, simulation is increasingly becoming an integral part of dental education to enhance the acquisition of critical skills (Boet *et al*., 2013; Sahin & Basak, 2021).

In Morocco, dental students typically spend six years in undergraduate medical education before continuing to a specialized residency training program (four years of training). Dental education involves theoretical and practical experiences preparing dental students to deliver dental services. An undergraduate curriculum usually consists of basic science coursework in the first two years, including courses in human embryology, histology, and biochemistry, among other courses. The next three years of the dental curriculum are devoted to more clinical training. In the sixth year, students undertake training in public and private clinical settings to prepare them for independent practice. At Casablanca Dental School, the dental treatment under general anaesthesia course is delivered in a lecture format in the fifth year. Students who choose the training or specialize in pediatric dentistry benefit from clinical training in general anesthesia at the Public University Hospital.

The COVID-19 pandemic suspended almost all hands-on clinical training, including dental internships involving general anesthesia. However, it underscored the need to incorporate alternative teaching methods to prevent overcrowding in classrooms and enable students to have initial interactions with patients.

The ultimate objective of this study was to investigate the impact of simulation as an educational method in teaching Dental Treatment under General Anesthesia.

## 2. Method

### 2.1. Research Design

This interventional study was designed to investigate the impact of simulation-based learning on the professional development of dental professionals. The test cohort comprised 33 pediatric, oral surgery odontology residents and interns representing the Dental Treatment Under Dental Anesthesia class. The participants were divided into two groups: one received a simulation-based teaching group (the simulation group). In contrast, the other group did not receive prior training in simulation-based teaching (the control group).

### 2.2. Setting

This study was conducted at Hassan 2nd University School of Dental Medicine and the International Medical Simulation Center of Mohammed 6th University of Health Sciences.

### 2.3. The Study

The study included three phases. In phase I, a 20-multiple choice questionnaire pre-test was administered to interns to assess their knowledge concerning the chosen topic, followed by a lecture on dental treatment under general anesthesia. In Phase II, a simulation session was organized for the simulation group, and a post-test was administered to them to assess their performance. The post-lecture test was administered to two groups: the test group (consisting of lecture and simulation) and the control group (involving lecture only).

In phase III, a simulation session was organized for students in the control group who had no prior simulation training. The aim of this simulation session for the control group was to allow these students to benefit from a simulation session and to have a new experience; it also served to measure students' satisfaction.

Participants' satisfaction in the simulation and control groups was evaluated using an online questionnaire. This assessment tool aimed to measure learner satisfaction with respect to the organization (welcome, group size, and duration), resources (room, materials, and training aids), the overall ambiance and interaction between learners and teachers, the relevance of the topics covered and readiness for technical aspects.

### 2.4. Organization of the Simulation Session

The simulation session consisted of (1) briefing, (2) simulation scenarios, and (3) debriefing. The briefing started with a guided discussion of the simulation, the role of each participant, and an outline of the objectives of the simulation session. Specifically, it lays the foundation for the simulation scenario and supports participants in achieving the goals of the simulation scenario. In the simulation scenario, the participants completed the simulation session by performing the skills and achieving the objectives (El Oury *et al*., 2021; Sahin & Basak, 2021).

In our case, the scenario consisted of a high-fidelity manikin that was programmed to respond to the following situation: a ten-year-old girl with autism spectrum disorder who presented with polyuria and complete refusal of care. Her previous attempts at sedative premedication and conscious sedation with nitrous oxide failed, leading to the decision for her to undergo management under general anesthesia.

Two trainee interns found themselves in the operating theater, standing before a simulator, with an anesthetist administering anesthesia to a patient. The learner protagonists were assigned a series of tasks. These included guiding the anesthetist toward nasal rather than buccal intubation, setting up the necessary equipment, and continuously monitoring various aspects of the procedure.

In the final part, a debriefing was provided to allow the participants to reflect on their simulation experience (feedback and evaluation). The trainer's debriefing was intended to highlight strengths and address weaknesses in an environment that nurtures a constructive learning context focusing on positive reinforcement.

It is important to note that the success of the simulation depends on how well each of these phases is executed (HAS, 2012).

### 2.5. Statistical Analysis

Data entry and analysis were carried out at the Laboratory of Community Health, Epidemiology, and Biostatistics at Hassan II University School of Dental Medicine in Casablanca, using SPSS v20. Quantitative variables were expressed by their means and standard

deviation, and qualitative variables by their number and percentage. Group performance was compared with the mean scores within each group by conducting t-tests. A significance threshold was set at a value of $p < 0.05$.

## 3. Results

33 postgraduate students were included in the present study. The mean scores for both groups before the course were low but increased significantly after the simulation session for the simulation group (Table I). For the same group, the mean score was significantly higher after the simulation session $p < 001$. (Table II). The students' performance in this group was greater than the control group, with a mean score significantly higher ($p = 0.024$) (Table III).

The results of the satisfaction survey are given in Table IV.

## 4. Discussion

Recently, simulation training has become an integral component of dental education and is used at dental schools worldwide. The traditional method of teaching, "See One, Do One, Teach One," used to improve healthcare professionals' knowledge and comprehension of surgery, is now being replaced by "See one—Practice—Do one—Practice—Teach one—Practice" model, which effectively captures the crucial role practice plays at each stage.

For this reason, in the context of this study, the study involved students at this stage (as dental interns) in their academic program.

Simulation is an experiential learning that offers dental practitioners a safe environment in which they can repeatedly practice a range of technical and non-technical skills without compromising patient safety (Boet *et al*., 2013; Buchanan, 2001). Other advantages of simulation include acquiring skills, exposure to clinical cases, reflection, enhanced communication skills, and applying theoretical knowledge to clinical practice. However, it is important to note that the success of simulation training depends on students' motivation level, feedback on their performance, and repetition of simulation scenarios (Boet *et al*., 2013).

Several studies have explored the advantages of simulation-based learning and have found a significant positive correlation between the frequency of achievement and self-reported ability. For instance, a very positive impact was observed through a postal survey of residents and assistants in pediatric dentistry at the University of Colorado Denver. In particular, after examining the impact of simulation training on dental residents and dental assistants' ability to manage medical emergencies, Tan (2011) concluded that teaching dentists and assistants about medical crisis management using simulation training would increase their confidence in managing real-world crises (Roy *et al*., 2018). In their simulation research, Ziv *et al*. (2003) indicated that using simulation appropriately in a professional setting helps students improve their clinical abilities without putting patients at risk.

Similarly, von Sternberg *et al*. (2007) used the Voxel-Man system and cadaveric pig jaws to assess the transfer of skills between two groups: Group 1, who received computer-based virtual surgical training before performing an apicectomy in a pig cadaver model, and Group 2, who had not received virtual apicectomy training. The experiment indicated that the Voxel-Man simulator improved residents' clinical skills (von Sternberg *et al*., 2007).

Simulation-based training has been consistently associated with positive effects on training outcomes. In a metanalysis study, Cook *et al*. (2011) attempted to determine whether simulation technologies for training healthcare professionals led to improved outcomes compared to no intervention. Results revealed a strong positive effect on association health care professionals' knowledge, skills, and behavioral outcomes. Effective simulation requires managing technical gestures, handling difficult patient care situations, and extensive use of a facilitator's time, both in preparing and implementing the activities. Similarly, our interventional study suggests

TABLE I: Evaluation Performance of the Simulation Group

| | Mean simulation group (+/− SD) | Mean control group (+/− SD) |
|---|---|---|
| Pre-lecture | 8.58 (+/−3.324) N = 17 | 8.88 (+/−3.324) N = 16 |
| Post-lecture | 12.37 (+/−2.553) N = 16 | 11 (+/−1.754) N = 14 |
| After simulation session | 12.56 (+/−1.861) N = 16 | |

TABLE II: Comparison of Students' Performance within the Simulation Group

| Simulation group (N = 16) | Mean (+/− SD) | Variance |
|---|---|---|
| Pre-simulation session | 8.58 (+/−3.324) | 11.04 |
| Lecture and simulation session | 12.56 (+/−1.861) | 3.46 |

TABLE III: Comparison of Performance of the Simulation and Control Groups

| Group | Mean (SD) | Variance |
|---|---|---|
| Simulation group (lecture and simulation) | 12.56 (+/−1.861) | 3.46 |
| Control Group (lecture only) | 11 (+/−1.754) | 3.07 |

TABLE IV: Satisfaction Levels of Participants After Simulation

| | Highly satisfied N (%) | Satisfied N (%) | Unsatisfied N (%) | Highly dissatisfied N (%) |
|---|---|---|---|---|
| 1. Organisation | | | | |
| -Welcoming the participants | 21 (65.4%) | 10 (30.8%) | 2 (3.8%) | 2 (3.8%) |
| -Group size | 19 (57.7%) | 11 (34.6%) | 3 (7.7%) | |
| -Length of briefing | 3 (7.7%) | 21 (65.4%) | 9 (26.9%) | |
| -Duration of the simulation scenario | 7 (23.1%) | 21 (65.4% ) | 3 (7.7%) | |
| -Duration of the debriefing | 13 (38.5%) | 16 (50%) | 4 (11.5%) | |
| 2. Resources | | | 2 (3.8%) | |
| -Room and equipment | 23 (69.2%) | 10 (30.8%) | | |
| -Training resources | 14 (42.3%) | 17 (53%) | | |
| 3. Atmosphere | | | | |
| -General atmosphere | 26 (76.9%) | 7 (23.1%) | 2 (3.8%) | |
| -Level of motivation and engagement of participants | 20 (61.5%) | 13 (38.5%) | | |
| -Participant-to-instructor interaction | 21 (65.4%) | 12 (34.6%) | | |
| -Participant-to-Participant interaction | 19 (56%) | 12 (36%) | | |
| 4. Pedagogy | | | | |
| -Relevance of topic | 21 (65.4%) | 10 (30.8%) | 2 (3.8%) | |
| -Level of difficulty | 11 (32%) | 18 (56%) | 4 (12%) | |
| 5. Value and usefulness of simulation sessions: | | | | |
| -Relational approach | 23 (72%) | 10 (28%) | | 2 (3.8%) |
| -Preparation of the technical aspect | 16 (50%) | 11 (34.6%) | 4 (11.5%) | |
| -Value of debriefing | 17 (51%) | 16 (49%) | | |
| 6. Global Assessment | | | | |
| -Global assessment of simulation training | 19 (57.7%) | 10 (30.8%) | 4 (11.5%) | |

that simulation-based training outperforms lecture-based instruction.

Debriefing following simulation is a key component of simulation-based education. Recent reviews of the simulation literature emphasize the value of the debriefing process., allowing for immediate feedback and evaluation of simulation scenarios aimed at improving learners' technical and non-technical skills, reflecting on their experiences, and learning from their mistakes. For example, in their study, Savoldelli *et al*. (2006) examined the value of the debriefing process during simulations. They compared the educational effects of verbal and verbal feedback with video to controls with no debriefing. They concluded that participants who benefited from a debriefing session significantly improved compared to controls (Savoldelli *et al*., 2006).

Debriefing can be accomplished through different methods; the success of debriefing methods depends on various factors, including the involvement of both learners, instructors' facilitation skills, debriefing time, quality of facilitators, and learners' level (Eppich & Cheng, 2015; Freeman *et al*., 2020).

This study employed the Kirkpatrick Four-Level Training Evaluation Model (response, learning, behavior, and results) to determine whether our simulation training program satisfied the goals of the participants' learning outcomes. A questionnaire was crucial in establishing how satisfied learners were with this simulation-based learning experience and identifying areas requiring further research. Although the results of the present study were promising, it is important to note that the effect of memory as a source of bias in estimating results should not be overlooked, as the same questionnaire was used before and after the simulation session. The limitations of this study should also be emphasized. Due to the Covid-19 pandemic, in this study, we restricted the assessment to the lower levels of the Kirkpatrick training assessment model, namely, level 1 (response) and level 2 (learning). In future research, we hope to implement levels 3 and 4 (actions) and level 4 (outcomes).

Dentistry is a growing field of study, with new developments constantly occurring. Dental education today relies heavily on simulations to help students learn and remember information. Integrating simulations into dental curricula is essential to provide students with opportunities to practice in a safe and realistic environment while getting constant feedback.

This study provides evidence supporting the use of simulation-based learning; the students in this study perceived simulation as a valuable and efficient solution for active learning in the basic and continuing education of health care professionals. The need for simulation-based training programs seems relevant. However, the main challenges are advanced and expensive equipment and a lack of

qualified workforce. For better information exchange, the simulation group should not exceed 15 students. Another challenge is that there is no guarantee that learning in the simulated environment will transfer to the clinical environment.

## 5. Conclusion

The increasing prevalence of dental anxiety among children globally has made general anesthesia a crucial treatment modality in specific cases. Despite its importance, this technique is predominantly taught to dental students during basic training through lectures alone, limiting their practical preparedness.

Acknowledging the transformative impact of simulation in dental education, we propose leveraging this tool to bridge the gap between theoretical knowledge and clinical application. Simulation provides students with a safe, controlled environment to practice essential procedures and refine soft skills, ensuring they are well-equipped for real-world scenarios.

We strongly encourage pediatric dentistry educators to adopt simulation-based training. By doing so, students will gain hands-on experience and confidence in managing dental care under general anesthesia, ultimately enhancing their competence and readiness for professional practice.

## Conflict of Interest

The author declares that there is no conflict of interest.

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