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Impact of Procedural Simulation on Learning and Satisfaction of Tunisian Dental Students

[1]Sana Bekri*, [1]Yosra Mabrouk, [1]Amel Labidi
Corresponding Author: *sanabekri2015@gmail.com
[1] University of Monastir, Monastir, Tunisia

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ABSTRACT

The demand for quality and the growing ethical demand, as well as the fear of risk and its legal implications, now require a minimum acquisition of the gesture practice before its realization on the patient himself, by virtue of the founding ethical principle of teaching by simulation: "never the first time on the patient". The dental student is required to provide care and perform technical acts on patients and must be operational in his practice at the end of his university course. From this perspective, simulation-based learning is increasingly becoming an essential teaching form in higher education, both in initial and continuing training. In this context, the present study was carried out at the removable partial denture (RPD) department of the oral medicine and surgery clinic of Monastir (Tunisia) in order to explore the impact of procedural simulation on the learning of technical gestures related to the rest seat preparations for metallic RPD. We included 74 4th year dental medicine students, the assessment of students' acquisitions was carried out by comparing the results of pre-tests and post-tests, and an observation grid was specially designed to measure the mastery of technical performance relating to dental preparations acquired by students following the procedural simulation session.

Keywords
Dental Preparation
Low Fidelity
Removable Partial Denture
Simulation

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Introduction

In the majority of cases, oral rehabilitation with removable partial denture (RPD) is preceded by a pre-prosthetic treatment. The enamel dental preparations (enameloplasty) is one of preprosthetic treatment required in metallic RPD. Their main goal would be to adapt the dental morphology to the terms of biomechanical balance. These preparations should be well conducted and harmless for the abutment teeth. It is therefore imperative to go through the practice of grinding to prepare rest seats allowing the best possible support and stabilization of the cast removable prostheses within the framework of a harmonious function. Dentistry, like any medical specialty, is invaded by the constant concern for the quality of training of learners and the safety of patients. In this sense, simulation as a teaching method, responds very well to this dual objective and aligns with the requirements of the High Authority of Health in terms of ethics: "never the first time on the patient" [1].

Simulation corresponds to a teaching method based on active learning on the part of the learner who finds himself immersed in an environment that is as real as possible. The student must then demonstrate reflection and mobilize his knowledge, in order to put it to the service of the situation in which he evolves [2]. Simulation–based learning has become for several years an essential teaching method in Western countries [2], both for students in training and for practicing dentists. However, in Tunisia, the use of this innovative teaching practice is still timid in the learning of different dental specialties. The objectives of this work was to evaluate the contribution of procedural simulation in the learning of dental preparations related to RPD metallic framework. And, to investigated participants' feelings towards medical simulation as a new educational tool applied in learning RPD.

Literature Review

The acquisition of theoretical knowledge provided by lectures and faculty tutorials is a necessary but far from sufficient element in medical training. It must be accompanied by learning the practice itself. It is with a view to "Better training for better care" that medical simulation has become for several years an essential teaching method in health care sector and a powerful tool for reinforcing the learning of technical gestures while improving communication between teams. In fact, the simulation based learning provide safe and practical approach for preclinical students [3].

Currently, the simulation has been introduced in several area, and demonstrate its efficacy compared with traditional methods [4]. According to the definition of the High Authority of Health (HAS), simulation in health consists of "the use of equipment (such as a mannequin or a procedural simulator), virtual reality [5]-[9] or a standardized patient, to reproduce situations or care environments, to teach diagnostic and therapeutic procedures

and to allow the repetition of processes, medical concepts or decision-making by a health professional or a team of professionals" [10].

There are then different types of simulations, the use of which is adapted according to the expected educational objectives. The procedural simulation, used in the following study for 4th year dental students, allows reproducing a precise technical gesture. Impacts of the simulation session on the evolution of students' acquisitions. The evaluation of simulation training is traditionally carried out using the Kirkpatrick classification [11]. This classification includes 4 increasing levels of training that could be summarized as: satisfaction, knowledge contribution, change of practice and clinical outcome.

Although the limited number of studies conducted in this field, the simulation as a learning approach has a positive impact on short term skill improvement and students was more confident in their knowledge [12]. The positive impact of simulation on learning has been also demonstrated by a meta-analysis of 609 studies that demonstrated the effectiveness of simulation for the education of healthcare professionals, with a significant impact on knowledge, skills (technical abilities), and behaviors (patient care) compared to no intervention [13]. Despite these promising results, some experimental data concerning the relative effectiveness of traditional learning techniques (lectures, courses) and simulation are discordant. Therefore, simulation must be integrated with other techniques within a program and not substituted by other forms.

Actually, some education institutions are trying to bring innovation in the teaching-learning process introducing the interactive virtual reality. According a published systematic review, it procure a positive control of identifying things and it aid students in learning, remembering, and passing concepts [14]. The use of Virtual Reality has been studied in different fields of dentistry, but there were limited studies assessing its use [15].

Material and Methods

A. Research Design

It is a descriptive analytical cross-sectional study conducted in the Removable Partial Prosthesis department in the dental medicine clinic of Monastir (Tunisia) in April 2023. The study targeted the fourth-year dental students, and was approved by the Ethical Committee of the Faculty of Dental medicine. The participants' selection was based on volunteering. A simulation session regarding dental preparations related to metal frame RPD was programmed. A call for participation was made on the faculty platform. Interested students were asked to contact the responsible person. Participants were divided into groups. Each group was summoned on a specific date to participate in the simulation training. The learners

have been already theoretically formed about the pre-prosthetic dental preparations related to the RPD metal framework during their lecture learning.

B. Learning Activities

The educational objectives have been clearly formulated and the scenario of the programmed low-fidelity simulation session was prepared (table1). Thus, at the end of the simulation learning session the student must be able to describe abutment teeth preparations related to the support of RPD metal framework, explain their benefits, choose the necessary material for their achievement and do correctly dental enamel preparations related to the support.

Table 1. Learning Activity

<table>
<tr><td>Scenario theme</td><td colspan="2">Enameloplasty related to the support of RPD metal framework.</td></tr>
<tr><td>Estimated time for briefing</td><td colspan="2">10 min</td></tr>
<tr><td>Estimated time for the scenario</td><td colspan="2">15 min / student</td></tr>
<tr><td>Estimated time for debriefing</td><td colspan="2">Real-time debriefing</td></tr>
<tr><td>Target group</td><td colspan="2">4th year dental students</td></tr>
<tr><td>Prerequisite knowledge</td><td colspan="2">-Role of dental support in prosthetic balance
-The shape of the occlusal rests and the Cingular rests</td></tr>
<tr><td>Context</td><td colspan="2">A patient consults the removable partial prosthesis department for prosthetic rehabilitation of a Kennedy Applegate Class I maxillary partial edentulism limited by 14 and 25.
Following the clinical examination and additional examinations, the prosthetic diagnosis is made and the decision is in favor of a restoration by PPA with a cast metal frame. Before taking the working impressions, the preparation related to abutment teeth must be carried out.</td></tr>
<tr><td>Learning objectives</td><td colspan="2">• Describe preparations in relation to the abutment teeth
• Recognize the material necessary for the practical realization of enameloplasty.
• Correctly carry out the preparations relating to dental support.</td></tr>
<tr><td>Expected skill</td><td colspan="2">Prosthetic management of a patient with partial maxillary edentulism using a metal frame removable partial denture</td></tr>
<tr><td>Equipment</td><td colspan="2">Plaster cast showing partial edentulism with natural teeth, coat, prospective framework design, gloves, mirror, probe, dental chair, turbine, 1 mm diameter diamond ball bur, diamond cylindrical bur, lens bur, fluoride gel, polishing discs, silicone mounted tips, brushes, polishing paste, safety glasses.</td></tr>
<tr><td colspan="3">Scenario progress</td></tr>
<tr><td colspan="3">First the student must identify the teeth which will provide support for the future RPD. Then he must select the necessary and specific material for dental preparation of rest seats. After that, the student must begin dental preparation; otherwise the facilitator will intervene to guide the material choice. For the occlusal rest seat: the student must mount the diamond ball bur (1 mm Φ) on the turbine, He begins by positioning the active part of the bur at the level of the marginal fossa then he descends the entire height of the bur, then he will move it in the vestibulo-lingual direction to widen the cavity up to 2 mm; in a second step he must place the bur at the level of the marginal crest to create a cavity 1 mm deep Then the two cavities must be joined to give the desired shape to the rest seat. The clearance of the walls and the beveling of the sharp angles must be done by a diamond cylindrical bur. For the cingulum rest seat: the student must select lens bur or shoulder bur. He will begin his preparation by making a groove from the mesial face to the distal face of the canine with a bottom inclined towards the center of the tooth, he must obtain an inverted V shape located on the cingulum of the canine. Then he finishes by making a vertical wall of relief parallel to the axis of insertion. These dental preparations must be completed by polishing with polishing discs and silicone mounted tips, then using a brush coated with polishing paste and the application of a fluoride gel.</td></tr>
<tr><td colspan="3">Validation</td></tr>
<tr><td>Cognitive Field</td><td colspan="2">Sensory-motor field</td></tr>
<tr><td>Describe preparations related to dental support
Recognize the equipment needed to perform enameloplasty related to support</td><td colspan="2">Correctly perform rest seats related to the RPD metallic framework</td></tr>
</table>

Three formed trainers conduct the simulation sessions. To insure the anonymity, a number was assigned to each student. Each simulation session takes place in three stages.

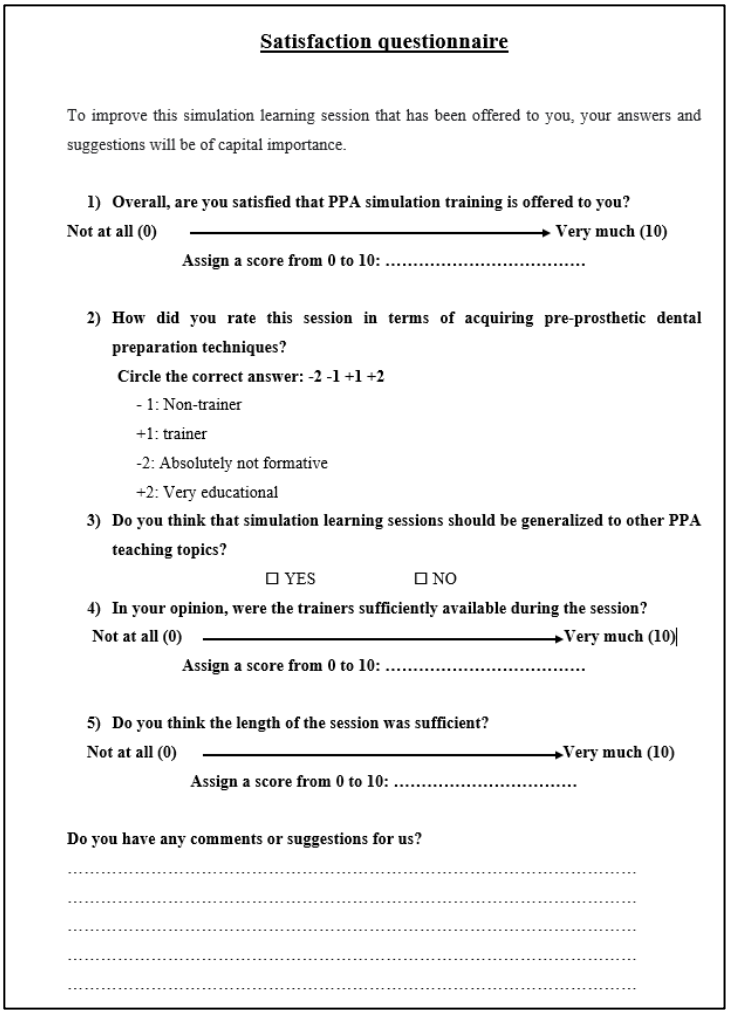
- The first stage: at the beginning, a pre-test was distributed to the students including different types of questions (multiple-choice questions and short open-response questions) to assess knowledge about the theme of the simulation session. A mark out of 10 was awarded to each learner according to a correction grid.
- The second stage: it consisted on proper simulation session including 3 phases: briefing, implementation, debriefing.
    - The briefing phase consisted on presenting the objectives of the training and its progress. It aimed to familiarize learners with the necessary material and to describe the dental preparations to be carried out. This phase lasted on average 10 minutes. The procedural models designed for the simulation session consisted on plaster models containing natural teeth (canine, molar and premolar) (Fig. 1).
    - The implementation phase: during this phase, participants were divided into small subgroups with their workstation (dental chair) and trainers. These lasts, firstly, carried a silent demonstration of the rest seats preparations in the procedural model. Secondly, the trainers repeat the demonstration describing each act. Subsequently, the learners commented on the procedure while the trainers performed it. Finally, the learners handled the material and performed the dental preparation related to the metal frame RPD on the procedural model.
    - Debriefing: during this stage, the trainers point out technical errors and give some tips to optimize dental preparations performed by students.
- The third stage: each student was invited to repeat the procedure in front of the trainer who assessed the technical skills acquired by student in relation to dental preparation using a pre-performed gird. A post-test was also administered to learners to assess the evolution of learners' knowledge.



Fig. 1. Procedural model

C. Satisfaction Measurement

Students' satisfaction with the simulation based-learning, has been assessed via questionnaire (fig.2) using a visual self-assessment scale (0-10). Students were considered very satisfied if the score was higher or equal to 8, satisfied if it was between 8 and 5, and not satisfied if it was lower than 5. Students were also asked to assess the impact of simulation learning on the acquisition of technical skills related to pre-prosthetic dental preparations; students made their judgment using the following scale: non-educational learning (-1), educational learning (+1), very educational learning (+2).



Satisfaction questionnaire

To improve this simulation learning session that has been offered to you, your answers and suggestions will be of capital importance.

1) **Overall, are you satisfied that PPA simulation training is offered to you?**

Not at all (0) ⟶ **Very much (10)**

Assign a score from 0 to 10: .....

2) **How did you rate this session in terms of acquiring pre-prosthetic dental preparation techniques?**

Circle the correct answer: -2 -1 +1 +2

- 1: Non-trainer
- +1: trainer
- -2: Absolutely not formative
- +2: Very educational

3) **Do you think that simulation learning sessions should be generalized to other PPA teaching topics?**

☐ YES ☐ NO

4) **In your opinion, were the trainers sufficiently available during the session?**

Not at all (0) ⟶ **Very much (10)**

Assign a score from 0 to 10: .....

5) **Do you think the length of the session was sufficient?**

Not at all (0) ⟶ **Very much (10)**

Assign a score from 0 to 10: .....

Do you have any comments or suggestions for us?

.....

.....

.....

.....

.....

Fig. 2. Satisfaction questionnaire

D. Statistical analysis

Statistical analysis of the data was done using SPSS Statistics software version 18. Quantitative variables were expressed by their means ± standard deviation. The mean of the pre-test scores is compared to the mean of the post-test scores by the Student t test for paired samples with a significant p value < 0.05.

Results

A. Impact of the "low fidelity" simulation learning session on technical skills

Seventy-four volunteered students participated in this study. The average score given by trainers when observing learners performing rest seats preparations related to metal framework was 6.42/10 ±0.96 [4.5-9].Two learners out of 74 had a grade lower than (5/10). A comparison between pre-test and post-test scores' was done. The mean score obtained by all learners in the pre-test was 2.5 ± 1, while it was 7.1 ± 1 in the post-test, with a statistically significant difference ($p < 0.001$). The progression of scores between the pre-test and the post-test was 180%. See Table 2.

Table 2. Evolution of learners' grades before and after the simulation session

	Pre-test			**Post-test**			***P***
Overall Average assessment (/10)	Average	Standard deviation	Extremes	Average	Standard deviation	Extremes	$<10^{-3}$
	2.5	1	[0.75-5.25]	7.1	1	[4.5-9.5]	
Progress (pre-test-post-test)		180%					

B. Students' satisfaction with the procedural simulation session

Concerning the overall students' satisfaction with the application of the simulation based-learning in removable partial denture discipline, 94.5% were satisfied with this experience with a mean of 6.97±1.9. The variation between each student's satisfaction levels is shown in Fig. 3. Eight students expressed complete satisfaction by giving the highest score of 10. Conversely, 4 learners were dissatisfied and gave scores ranging from 2 to 4.

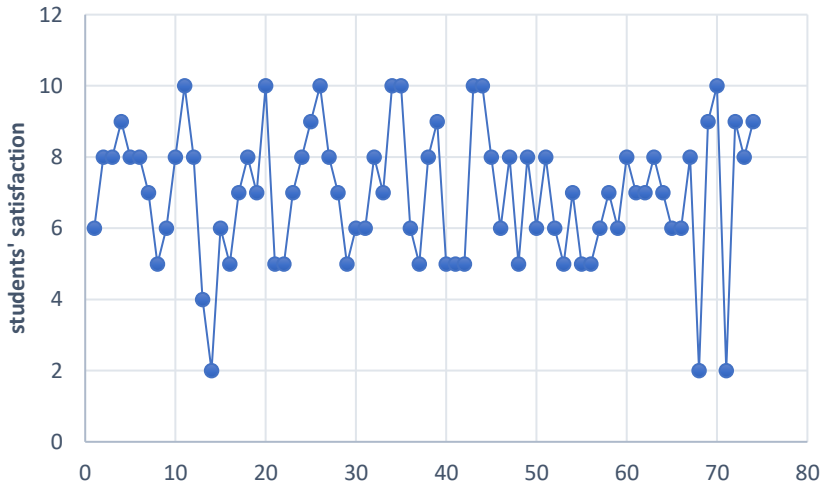


Fig. 3. Student satisfaction variation

C. Variation in students' satisfaction related to the procedural simulation session

Concerning the students' satisfaction with their skills improvement related to dental preparation techniques, 20.3% found the procedural simulation session was "very formative",

73% found it "formative", 6.7% found it not formative. Asking them about their opinions regarding the simulation session's generalization to other themes of removable partial prosthesis, students were divided into two groups, 93% found this useful, however, 7% of them did not share the same opinion. Asking learners about their satisfaction with trainers' availability, the average score given through their responses was 6.43±1.4 with a maximum score of 9 and a minimum of 3. Concerning their satisfaction with the duration of the simulation session, the mean score given was 5.46 ±1.4 with a maximum score of 9 and a minimum of 2.

Discussion

The findings of this study highlight the effectiveness of procedural simulation in dental education, particularly in the acquisition of technical skills required for removable partial denture (RPD) framework preparation. The significant increase in cognitive acquisition, as demonstrated by the improvement in pre-test and post-test scores (from 2.5/10 ± 1 to 7.1/10 ± 1), supports previous research emphasizing the benefits of simulation-based learning (SBL) in health sciences education [16][17].

One of the key advantages of simulation is its ability to enhance both psychomotor and cognitive learning. By allowing students to actively engage in the learning process, simulation fosters deeper understanding and retention of procedural skills [18]. Additionally, it provides an opportunity for repetitive practice, which is essential for skill mastery in technical disciplines such as dentistry [19]. This aligns with previous studies that have shown simulation-based training to be more effective than traditional learning methods in skill acquisition and competency development [20].

The high levels of satisfaction among learners in this study (94.5%) further reinforce the positive perception of simulation-based education in dentistry. This is consistent with research by Torkington et al. [21], which demonstrated that students perceive simulation training as a valuable complement to conventional teaching methods. Moreover, the fact that 93% of students advocated for the generalization of simulation-based teaching to other RPD-related topics underscores the need for broader implementation of simulation in dental curricula.

Ethically, the principle of "never the first time on a patient" is a fundamental guideline in clinical education [20]. Simulation training upholds this principle by ensuring that students acquire and refine their skills in a controlled, risk-free environment before transitioning to real patient care. This approach not only enhances student confidence and competence but also prioritizes patient safety, an essential consideration in contemporary dental education [22].

In conclusion, the findings of this study confirm the efficacy of procedural simulation in improving both technical and cognitive skills in dental students. Given its advantages, there

is a strong argument for expanding the integration of simulation into dental education to enhance learning outcomes and ensure ethical clinical practice. Future research should explore the long-term impact of simulation training on clinical performance and patient care outcomes.

Conclusion

This study showed that procedural simulation is an engaging and effective way for dental students to develop technical skills in preparing RPD frameworks. It also helped improve their understanding, as seen in the significant increase in test scores from an average of 2.5/10 to 7.1/10. Most students (94.5%) felt satisfied with their progress, and 93% believed that simulation-based learning should be applied to other areas of RPD training. Using simulations in dental education offers many benefits. It allows students to actively participate in their own learning, practice as many times as needed to gain confidence, and develop both cognitive and practical skills. Importantly, it aligns with the ethical principle of clinical training—ensuring that students never perform a procedure on a patient for the first time without proper preparation.

Limitations

This study has some limits. First, the simulator used was simple and did not allow an appropriate assessment of interpersonal skills. Second, the number of learners during simulation learning sessions was large. The absence of monitoring over time was also a limit of this study, in fact, regular practice is necessary to maintain the anchoring of its execution in procedural memory and to perpetuate the acquired skills after this initial learning session.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Authors



Sana Bekri is an Associate Professor in Dentistry and a member of the International Association of University Pedagogy (AIPU) – Tunisian Section. She serves as an advisory member of the pedagogy committee at the Faculty of Dentistry and is a member of the Research Laboratory "Clinical Biological and Dento-Facial Approach (ABCDF)" at the Faculty of Dental Medicine, University of Monastir, Tunisia. (Email: sanabekri2015@gmail.com).



Yosra Mabrouk is an Associate Professor in Dentistry and a member of the pedagogy committee at the Faculty of Dental Medicine, University of Monastir, Monastir, Tunisia. She is also a trainer in simulation in health science. With her experience and dedication to dental education, Yosra actively contributes to enhancing learning quality through simulation methods and pedagogy development. (email: mabroukyosra2021@gmail.com).



Amel Labidi is an Associate Professor in Dentistry at the Faculty of Dental Medicine, University of Monastir, Tunisia. She specialized in prosthodontics and focuses on modern implantology in her clinical practice. Dr. Labidi has presented at numerous national and international conferences and has published several scientific articles in indexed journals. Her expertise and dedication make her a valuable asset to the dental education community. (email: amellabidi16@yahoo.fr).