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EFFECTIVENESS OF SIMULATION-BASED TRAINING IN THE DEVELOPMENT OF LAPAROSCOPIC SURGERY SKILLS

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Relevance: In recent years, laparoscopic surgeries have been widely used in clinical practice and have gained particular importance due to reduced rehabilitation time and a lower rate of complications in patients. However, the successful performance of laparoscopic surgical procedures requires a high level of psychomotor skills, visuomotor coordination, and spatial thinking from the surgeon [1,2]. The development of practical skills based on the traditional “mentor—trainee” model is associated with a number of challenges, including patient safety concerns, limited operative time, and the risk of errors [3]. In this regard, simulation-based training technologies are considered an integral part of modern surgical education [4,5].

Materials and Methods: This study was conducted at the Urgench State Medical Institute within the framework of the implementation of the driver innovative project “Improving the effectiveness of developing skills in high-tech surgical interventions among surgeons of the Lower Amu Darya region” (Appendix 7a, item 109), in accordance with the Resolution of the President of the Republic of Uzbekistan No. 307 dated July 6, 2022, “On organizational measures for the implementation of the Strategy for Innovative Development of the Republic of Uzbekistan.”

The study was carried out in 2024—2025 at the training and simulation center. The development of practical skills in laparoscopic surgery was performed through the sequential use of the iModels box trainer, as well as the LAPARO Analytic and LAPARO APEX simulators.

A total of 265 participants of simulation training courses were included in the study. The age of the participants ranged from 23 to 45 years, with a mean age of 31.8 ± 4.6 years. In terms of gender distribution, 62% were male and 38% were female. The overall medical experience of the participants ranged from 1 to 15 years. Depending on their experience in laparoscopic practice, the participants were divided into three groups: **Group I** — participants with no prior experience in laparoscopy (n = 112, experience 1—3 years); **Group II** — participants who had assisted in laparoscopic

surgeries but had limited independent practice (n = 93, experience 3—7 years); **Group III** — participants with minimal independent experience in laparoscopic procedures (n = 60, experience 5—15 years).

Results: In Group I (no experience, n = 112), by the end of the training, the mean task completion time decreased by 38.6% ($p < 0.001$), while the number of technical errors was reduced by 42.1%. The overall integral performance score significantly increased compared to the baseline level.

In Group II (n = 93), after the Analytic stage, an improvement in movement accuracy and optimization of instrument trajectories was observed. In the APEX simulator, the performance of complex tasks improved by 29—33% compared to baseline values ($p < 0.01$).

In Group III (n = 60), despite initially high baseline performance, additional positive dynamics were recorded after simulation training in coordination, precision of dissection, and time efficiency ($p < 0.05$).

Conclusion: The obtained results confirm the effectiveness of a stepwise model of simulation-based training in the development of laparoscopic skills. In particular, the acquisition of basic skills using the iModels box trainer provided a solid foundation for subsequent analytical and advanced stages of simulation.

Objective indicators obtained from the LAPARO Analytic simulator played an important role in assessing the accuracy of movements and time efficiency of the trainees. The comprehensive scenarios of the LAPARO APEX simulator created an environment максимально close to real clinical practice, facilitating the simultaneous development of clinical thinking and technical proficiency.

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