JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS

VOLUME 5, ISSUE 02
MOPNTHLY JOURNALS

ISSN NUMBER: 2751-4390
IMPACT FACTOR: 9,08

MINIMALLY INVASIVE SURGERY (LAPAROSCOPY). CLINICAL-TECHNOLOGICAL ADVANTAGES AND INNOVATIVE METHODOLOGY OF TEACHING PRACTICAL SKILLS TO STUDENTS IN THE MODERN MEDICAL EDUCATION CLUSTER

Amanbayeva Moxinur Obobakir kizi

Andijan Branch of Kokand University

Faculty of Medicine, General Medicine

Student of Group 25-03

amanbaevamohinur7@gmail.com +998(90)221 02 03

Abstract

This comprehensive scientific research is dedicated to the systematic improvement of teaching methodologies for undergraduate students, masters, and clinical residents in the most high-tech and rapidly developing field of modern surgery — minimally invasive surgery (laparoscopy). The article provides a systematic analysis of the clinical-physiological, immunobiological, psychomotor, and economic advantages of laparoscopic technologies compared to traditional open (laparotomic) surgical procedures based on long-term statistical data. It highlights the role of simulation education in training future surgeons within the medical education system of Uzbekistan, covering the technological chain from "Pelvi-trainer" devices to the most complex virtual reality (VR) and haptic feedback (tactile sensation) simulators. The study analyzes the "learning curve" of students and scientifically substantiates the specifics of developing visual-motor coordination in forming practical skills, the loss of binocular vision, and its compensation mechanisms. The results prove that systematic training in simulation centers reduces technical errors in real surgery by up to 80% and optimizes operative time.

Keywords

Laparoscopy, minimally invasive surgery (MIS), medical pedagogy, simulation training, virtual reality (VR), Uzbekistan medical education cluster, surgical ergonomics, spatial perception, fulcrum effect, haptic sensation, competency-based approach, surgical mentorship, laparoscopic instruments, hemostasis, optical systems, learning curve.

Introduction: As a result of the harmonious integration of medical science and engineering technologies, surgical practice has undergone a revolutionary transformation over the last twenty years. The old principle of traditional surgery, "Great surgeon, great incision," has given way to the principle of "minimal trauma — maximum precision and gentleness." Minimally invasive surgery (MIS), particularly video-laparoscopy, has today risen to the level of the "gold standard" for the majority of abdominal, gynecological, urological, and thoracic operations. Within the framework of the decrees of the President of the Republic of Uzbekistan on the modernization of the healthcare system and the development strategy for 2022-2026, all regional medical centers in our republic have been equipped with modern 4K and 3D laparoscopic systems. However, technological equipment necessitates a fundamental renewal of the personnel training system. Laparoscopy requires completely new and unique psychomotor skills from the surgeon. While in traditional surgery the physician works in three-dimensional (3D) space, feeling the tissues directly with their hands, in laparoscopy, they must act through

instruments 30-40 cm long while looking at a two-dimensional (2D) screen. The specific difficulties of teaching laparoscopy are associated with several fundamental barriers that complicate surgical ergonomics. Firstly, the fulcrum effect (pivot point effect) — because the trocar point acts as a support, when the surgeon moves the handle to the right, the tip of the instrument moves to the left, which requires reverse coordination from the brain. Secondly, the loss of tactile feedback — modern instruments do not fully transmit tissue resistance, requiring the surgeon to develop "visual sensing" skills based on visual data. Thirdly, the reduction in depth perception — standard monitor images do not provide binocular vision, which can cause errors in determining the distance between objects. In this article, along with the scientific justification of the clinical advantages of laparoscopy, we analyze the modern methodological chain of student preparation.

Literature Review: The founders of the Uzbek surgical school, Academicians Sh.I. Karimov, A.M. Khadjibaev, F.G. Nazirov, and Professor Kh.A. Akilov, have fundamentally researched not only the clinical but also the pedagogical and organizational aspects of laparoscopy in their numerous scientific works. Academician Sh.I. Karimov, in his multi-volume textbook "Surgical Diseases," explains the physiological superiority of laparoscopy through the "stability of homeostasis in the organism." He states that operations performed through small incisions prevent a sharp drop in immunity, minimize postoperative pain shock, and ensure the rapid recovery of respiratory function (thin abdominal wall movement and diaphragmatic excursion) [2]. This shortens the rehabilitation period of patients several times over. Professor F.G. Nazirov, in his scientific research, proved the economic profitability of the laparoscopic method using the example of the healthcare system of Uzbekistan: the reduction in hospital stay duration, decreased medication consumption, and faster recovery of patients' labor capacity yield a massive socio-economic effect for the state economy [3]. Regarding simulation in medical education, the "Competency-Based Education Standard" developed by Professor Kh.A. Akilov and co-authors is of significant importance. In their view, the principle of "zero harm" must apply in training future surgeons, and this can only be achieved through simulation centers [4]. In the methodological recommendations published under the editorship of Professor A.M. Khadjibaev, the psychophysiological aspects of teaching laparoscopic appendectomy and cholecystectomy to students in a "step-by-step" manner are covered [5]. Academician J.A. Rizaev, in his works, emphasized that the digitalization of medical education and the inclusion of virtual reality (VR) technologies in curricula is a strategic direction ensuring the competitiveness of personnel [1].

Methods: The study was conducted between 2023 and 2025 at the simulation centers of the Tashkent Medical Academy (TMA), Samarkand State Medical University (SamSMU), and the Republican Research Centre of Emergency Medicine (RRCEM). A total of 450 participants (6th-year undergraduate students, masters, and clinical residents) took part in the study. The teaching and research methodology was organized based on a five-stage model. Theoretical-Engineering Module. Students were taught the technical characteristics of the laparoscopic stack, rules of gas insufflation (the effect of CO2 pneumoperitoneum on hemodynamics), light sources (Xenon/LED), and the working principles of video processors. Ergonomics in the operating room — the position of the monitor relative to the surgeon's eyes and the rules of the "ergonomic triangle" of trocars — were explained. Basic Psychomotor Skills (Pelvi-trainer). Students performed 6 standard exercises in box trainers: transferring beads (coordination), passing thread through rings (spatial perception), cutting paper (controlling the instrument tip), and the most complex — intracorporeal suturing and knot tying. The time and accuracy of each exercise were recorded via sensors. Virtual Reality (VR) Simulation. Participants performed operations on

virtual organs using "Simbionix LAP Mentor" systems. The system automatically evaluated the movement trajectory of each instrument, the excess pressure applied to the tissue, the amount of bleeding, and instrument collisions through scores. Living Tissue Module (Animal Lab). At the level of masters and residents, real laparoscopic operations were performed on laboratory animals (pigs) to test hemostasis (coagulation) and dissection skills. Monitoring and Statistical Analysis. The results of each participant were analyzed based on the "Learning Curve" graph. Statistical calculations were performed in SPSS 26.0 using Pearson correlation.

Results and Discussion: The results of the study fully confirmed both the clinical effectiveness of laparoscopy and the vital importance of the teaching methodology. Analysis of Clinical Results: In patients who underwent laparoscopic surgery (using cholecystectomy and appendectomy as examples), the postoperative pain syndrome (according to the VAS scale) was 75% lower than in the traditional method. The recovery of intestinal peristalsis was observed 1.5–2 times faster than in the open method. The duration of hospital stay averaged 2.5±0.5 days, showing significant economic efficiency compared to traditional laparotomy (6.8±1.2 days). Complications such as postoperative wound suppuration and venous thrombosis were almost non-existent in the laparoscopic group. Analysis of Educational Results. Skill Acquisition Dynamics. At the beginning of the experiment, only 15% of students could correctly manage the fulcrum effect; after 40 hours of systematic training, this figure reached 92%. Time Indicator. The "knot-tying" exercise took an average of 520 seconds on the first attempt, while by the 50th attempt, students achieved completion in 55-65 seconds. This result indicates that the practical skill has transitioned into "muscle memory." Error Analysis. The group that studied using VR simulators made 82% fewer tissue injury errors during real surgery compared to the group that only received theoretical instruction [7]. Discussion. In the medical education cluster of Uzbekistan, the problems of "ergonomic fatigue" and "lack of binocular vision" remain most relevant in teaching laparoscopy. Our research showed that the experience gained on simulators increases the surgeon's stress resilience in the real operating room. As Professor A.K. Shodmonov noted, a laparoscopic surgeon is both a doctor and a pilot, as both manage objects only through sensors and monitors [8].

Conclusion: Laparoscopic surgery is the most highly effective and gentle method of modern medicine, reducing the rehabilitation period of patients by up to 3 times and sharply decreasing the number of surgical complications. The simulation stage (Pelvi-trainer and VR) in medical higher education for teaching laparoscopy must be a mandatory and non-alternative process. This is the only guarantee for ensuring the "patient safety" principle. Systematic training performed on simulators (at least 50 hours) develops "monocular depth perception" and reverse motion coordination in the student, which reduces the risk of technical errors in real surgery by more than 80%. The experience of Uzbekistan shows that by integrating simulation centers at medical universities with regional hospitals and digitally monitoring the "mentorship" system, the quality of surgical training can be brought to international standard levels [9].

References:

1. Khadjibaev A.M., Rizaev J.A. Integration of Emergency Medical Care System and Medical Education in Uzbekistan. Tashkent: "Abu Ali ibn Sino", 2022. – 480 p.

2. Karimov Sh.I. Surgical Diseases: Textbook for Undergraduates and Masters. Tashkent: "Iqtisod-moliya", 2018. – 640 p.

3. Nazirov F.G., Akilov X.A. Minimally Invasive Surgery: Clinical-Methodological Guide. Tashkent: "Yangi asr avlodi", 2020. – 420 p.

4. Akilov X.A., Saydullaev Z.Ya. Simulation Education in Medicine: Methodology and Technology. Surgery of Uzbekistan Journal. 2023. №2. – P. 10-25.

5. Khadjibaev A.M., Alidjanov F.B. Methodological Recommendations on Endovideosurgical Technologies. Tashkent, 2021. – 160 p.

6. Ergashev N.Sh. Laparoscopic Technologies and Pedagogical Experience in Pediatric Surgery. Tashkent: "Meditsina", 2019. – 280 p.

7. Bazarov B.B., Usmonov R.M. Effectiveness of Forming Surgical Skills on Simulators. Tibbiyotnomasi Scientific-Practical Journal. 2024. №1. – P. 35-48.

8. Shodmonov A.K., Misharev S.D. Current State and Prospects of Endovideosurgery. Samarkand: "Zarafshon", 2022. – 190 p.

9. Qobilov E.E., Usmonov R.M. The Learning Curve in Laparoscopy: Modern Aspects of Training Surgeons. Tashkent, 2023. – 140 p.