Impact of Scenario-Based Teaching Centered on Gynecological Laparoscopic Surgical Procedures on Clinical Decision-Making Ability and Operative Standardization Among Resident Physicians

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AIM: Scenario-based teaching has demonstrated potential in medical education, but its application to comprehensive gynecological laparoscopic training remains limited. This study aimed to evaluate the impact of scenario-based teaching centered on the complete gynecological laparoscopic surgical procedure on resident physicians' clinical decision-making ability, operative standardization, and training satisfaction.

METHODS: This single-center retrospective cohort study included 47 resident physicians who underwent laparoscopic training in the Department of Obstetrics and Gynecology at Zhoukou Central Hospital between April 2021 and April 2025. Based on the training methods implemented during the teaching phase, participants were assigned to a routine training group (n = 23) or a scenario-based training group (n = 24). The routine training group received conventional theoretical instructions and basic laparoscopic simulation training, whereas the scenario-based teaching group additionally participated in scenario-based simulation teaching modules designed around the complete surgical workflow. Following completion of the training program, participants underwent a comprehensive assessment using a closed-book theoretical examination, the Global Assessment of Laparoscopic Skills (GOALS), structured case-based clinical decision-making scoring, and a teaching satisfaction questionnaire. Differences in theoretical knowledge, operative skills, clinical decision-making ability, and satisfaction were compared between the two groups.

RESULTS: After training, the theoretical examination scores of the scenario-based teaching group were significantly higher than those of the routine training group ($p = 0.047$). In the assessment of laparoscopic operative performance, the scenario-based teaching group significantly outperformed the routine training group across all GOALS dimensions (depth perception, bimanual dexterity, efficiency, tissue handling, and autonomy), and total score (all $p < 0.05$). In terms of clinical decision-making ability, the scenario-based training group achieved higher scores than the routine training group in diagnostic accuracy, surgical plan rationality, and identification of key risk points ($p < 0.05$), with particularly marked differences observed in surgical plan rationality and key risk point identification (both $p < 0.001$). Regarding training satisfaction, the scenario-based training group reported significantly higher scores across all six dimensions, including content arrangement rationality, applicability of teaching format, participation in practical activities, perceived improvement in decision-making ability, perceived enhancement in operative skills, and overall satisfaction (all $p < 0.05$).

CONCLUSIONS: Under the conditions of this study, scenario-based teaching centered on the complete gynecological laparoscopic surgical procedure was associated with significant improvements in residents' acquisition of theoretical knowledge, laparoscopic operative standardization, and clinical decision-making competence. Moreover, trainees reported higher levels of satisfaction with the teaching process. These findings suggest that this teaching model may represent an effective strategy for optimizing standardized training in gynecological laparoscopic residency programs.

Keywords: gynecological laparoscopy; scenario-based teaching; clinical decision-making; resident education

Introduction

With the rapid advancement of minimally invasive techniques, laparoscopic surgery has been widely adopted in the diagnosis and treatment of benign and malignant gynecological diseases [1,2]. Compared with conventional open surgery, laparoscopic procedures offer advantages including reduced surgical trauma, faster postoperative recovery, and shorter hospital stay. However, they also impose substantial demands on surgeons' spatial perception, hand-eye coordination, procedural standardization, and clinical decision-making ability [3,4,5]. Especially during standardized residency training, how to systematically improve trainees' understanding and execution of the complete laparoscopic surgical process within limited clinical exposure has become an important concern in contemporary medical education.

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Traditional gynecological laparoscopic teaching predominantly relies on intraoperative instruction and experiential knowledge transfer, with resident physicians acquiring experience primarily through observation and gradually increasing participation in surgical procedures [6]. However, this teaching approach has several limitations. Clinical cases are inherently non-reproducible, limiting trainees' exposure to critical operative steps and complex clinical scenarios. Additionally, teaching activities frequently emphasize technical manipulation while providing insufficient training in systematic clinical decision-making. Furthermore, concerns about patient safety markedly restrict opportunities for residents to engage in trial-and-error learning during actual surgical procedures. Therefore, conventional clinical teaching alone is no longer sufficient to meet the needs of modern gynecological laparoscopic training.

In recent years, simulation-based training has gradually become an important adjunctive teaching approach in surgery and obstetrics and gynecology education [7]. Previous studies have shown that laparoscopic simulation training enables trainees to repeatedly practice operative techniques in a safe, controlled environment, thereby shortening the learning curve and improving technical proficiency [8,9,10,11]. Various simulation approaches, including low-fidelity trainers, high-fidelity simulation systems, virtual reality platforms, and animal or *ex vivo* tissue models, have been widely applied in basic skills acquisition and specialized operative training [9]. Existing evidence further suggests that systematic simulation training can improve operative efficiency, reduce technical errors, and improve overall surgical quality [12]. However, current simulation training programs primarily focus on isolated technical skills or discrete operative maneuvers, while placing relatively limited emphasis on integrated clinical decision-making throughout the surgical process.

Scenario-based simulation teaching, an educational approach centered on real or highly simulated clinical scenarios, emphasizes the organic integration of theoretical knowledge, operative skill development, and clinical decision-making processes [13]. By constructing scenarios that closely resemble actual clinical practice, this approach encourages learners to analyze clinical problems, make judgments, and formulate management decisions, thereby enhancing clinical reasoning and comprehensive competence. Scenario-based simulation teaching has been increasingly incorporated into medical education and has been shown to improve learners' clinical decision-making ability, risk identification, and teamwork awareness [14,15]. A previous study has shown that teaching models designed around real clinical scenarios can effectively strengthen students' ability to manage complex clinical situations and improve procedural standardization [16].

In obstetrics and gynecology education, scenario-based simulation has been gradually introduced into training in delivery management, perioperative communication, emergency and critical care, and complication management [17,18]. However, existing studies have primarily focused on isolated clinical scenarios or specific emergency management procedures, resulting in relatively fragmented teaching content. In gynecological laparoscopic education, current research has primarily emphasized simulation training for specific operative techniques, with comparatively limited attention to integrating preoperative assessment, intraoperative decision-making, and postoperative management into a unified, scenario-based teaching framework encompassing the complete surgical process. Therefore, further investigation is warranted to determine how scenario-based teaching can be systematically implemented within the surgical workflow as the principal framework, and to evaluate its impact on resident physicians' clinical decision-making ability and operative standardization can be scientifically evaluated.

To address these gaps, the present study introduces a scenario-based teaching model centered on the complete surgical procedure, organically integrating theoretical instruction, simulated operative training, and clinical scenario exercises. This model was designed around the complete workflow of gynecological laparoscopic surgery and focused not only on operative techniques but also on preoperative assessment, intraoperative decision-making, and postoperative management. Through structured scenario-based design, the model aims to strengthen residents' overall understanding and standardized implementation of the surgical process. This study systematically evaluated the effectiveness of this scenario-based teaching model in gynecological laparoscopic residency training, providing evidence-based support for optimizing laparoscopic education and improving residents' comprehensive clinical competence.

Methods

Research Design and Participants

This study was a single-center, retrospective cohort study. The study population consisted of resident physicians in the Department of Obstetrics and Gynecology at Zhoukou Central Hospital who underwent laparoscopic training between April 2021 and April 2025. All data were retrospectively collected from the teaching management system and periodic assessment records. The study protocol was reviewed and approved by Zhoukou Central Hospital's teaching management department.

The inclusion criteria were as follows: (1) participation in the standardized residency training program; (2) complete participation in the laparoscopic training program and completion of all pre-training and post-training theoretical and skills assessments; and (3) absence from less than 20% of the total scheduled training hours during the training period. The exclusion criteria included: (1) failure to complete the final assessment; (2) missing key evaluation indicators; and

(3) withdrawal from the training program before completion.

Based on the teaching methods received, participants were divided into two groups. Residents who received traditional laparoscopic training were assigned to the routine training group, while those who received comprehensive training incorporating scenario-based teaching centered on the surgical procedure were assigned to the scenario-based teaching group. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Zhoukou Central Hospital (approval number: 2026-01).

Notably, the proportion of first-year residents included in the study was relatively low. According to the institutional training curriculum, gynecological laparoscopic training is primarily provided to residents who have completed their foundational clinical rotations, typically during the second and third years of residency training. In contrast, first-year residents primarily focus on acquiring fundamental clinical skills and are generally not scheduled to participate in laparoscopic training programs.

Training Methods and Content

Conventional Training Model

Routine training was implemented in accordance with the detailed requirements for obstetrics and gynecology training outlined in the "Standardized Training Content and Standards for Resident Physicians (2022 Edition)" [19]. Teaching responsibilities were undertaken by instructors with more than 3 years of experience at the level of associate chief physician or chief physician. Before the initiation of the training program, all instructors received standardized preparatory training to unify teaching objectives, instructional content, and operative standards, thereby ensuring homogeneity in the training process.

Theoretical instruction was conducted twice weekly, with each session lasting 3–4 hours. Teaching focused on common gynecological diseases managed laparoscopically and routine operative procedures, including diagnostic criteria, surgical indications, selection of surgical procedures, and principles of perioperative management for conditions such as ectopic pregnancy, ovarian cysts, and uterine fibroids. The lectures combined theoretical explanations with standardized case analyses, systematically covering disease etiology, clinical manifestations, imaging features, and surgical management strategies while incorporating discussion of representative clinical cases. However, all instructional cases were standardized and did not include unrelated or extraneous clinical information.

Skills training was conducted at the hospital's clinical skills training center. Trainees practiced basic laparoscopic techniques, including camera stabilization and control, bimanual coordination, basic suturing and knot tying, use of energy devices, and hemostatic techniques, using laparoscopic simulators and training models. Instructors provided real-time demonstrations and standardized guidance, enabling trainees to acquire and reinforce basic operative procedures through repeated simulation-based practice.

Scenario-Based Simulation Teaching Model

Comprehensive training, using a scenario-based teaching model centered on the surgical procedure, was implemented in addition to routine training. While maintaining consistency with the routine training group in terms of theoretical lecture content and basic skills training requirements, an additional scenario-based simulation teaching module structured around the complete surgical workflow was incorporated. Scenario-based teaching sessions were conducted once weekly, with each session lasting approximately 90 minutes and consisting of scenario simulation (50 minutes), centralized feedback and discussion (25 minutes), and a 15-minute case briefing conducted at the beginning of the session.

The scenario-based teaching model used the complete surgical procedure as the principal framework, integrating preoperative assessment, surgical strategy selection, intraoperative management, and risk management into a continuous simulated clinical scenario. The teaching team developed standardized cases based on common gynecological laparoscopic surgical procedures, including laparoscopic surgery for ectopic pregnancy, ovarian cystectomy, and myomectomy. Each scenario included a comprehensive patient medical history, physical examination findings, and auxiliary examination results, with predefined key decision-making points and dynamic scenario modifications incorporated into the simulation process.

At the beginning of each simulation session, four resident physicians were assigned to a training group. To ensure balanced participation and equitable learning opportunities, the role of lead surgeon was rotated across cases, allowing each participant to assume primary responsibility for clinical decision-making during different scenarios. During the preoperative assessment phase, the lead surgeon was required to review the clinical information within a limited timeframe, determine the surgical indications, assess surgical feasibility, and formulate a preliminary surgical plan. Other group members were encouraged to provide supplementary opinions and alternative considerations. In addition, all participants were required to independently record their preoperative judgments and supporting rationale in a standardized decision-making record sheet to facilitate objective assessment of the clinical decision-making process.

The intraoperative simulation phase was subsequently conducted using a high-fidelity laparoscopic simulation platform and anatomical models, following the sequence of an actual surgical procedure. Participants sequentially completed operative tasks such as puncture point design, establishment of pneumoperitoneum, abdominal cavity exploration, identification of key anatomical structures, and execution of major operative steps. During the simulation,

instructors dynamically introduced scenario modifications at predefined key stages based on a standardized script. These modifications included supplementary surgical history, imaging findings indicating adhesion risk, simulated difficulty in identifying intraoperative anatomical planes, and increased intraoperative bleeding. Participants were required to reassess procedural risks and adjust operative strategies in real time as clinical information evolved.

Immediately after completion of the scenario simulation, a structured group feedback session was organized. Instructors reviewed the processes of preoperative assessment, surgical procedure selection, identification of key anatomical structures, and risk management according to the chronological sequence of the surgical workflow. Participants were required to explain the reasoning and rationale for each key decision-making step. Instructors then analyzed the procedures using standardized surgical pathways and identified deviations in operative performance and clinical decision-making logic. After the session, each participant completed a written reflective summary of the scenario-based learning experience, systematically reviewing the key operative steps and risk management strategies involved in the complete surgical procedure.

Baseline Data Collection

Baseline demographics and training-related characteristics of participants were collected, including age, gender, duration of standardized residency training, number of completed departmental rotations, residency year, and previous experience in laparoscopic teaching and training.

Teaching Evaluation Indicators

Theoretical Assessment

The theoretical assessment was conducted using a standardized closed-book examination. The examination was based on the current residency training syllabus and covered laparoscopic anatomy, surgical indications and contraindications, principles of managing common intraoperative complications, and understanding key operative procedures. The examination consisted of multiple-choice, true-or-false, and scenario-based questions, with a maximum total score of 100 points. Higher scores indicated greater mastery of theoretical knowledge.

Assessment of Laparoscopic Operative Skills

Laparoscopic operative skills were evaluated using the Global Operative Assessment of Laparoscopic Skills (GOALS). The GOALS scale, originally proposed by Vassiliou et al. [20], has been shown to be reliable and valid, and is widely used to assess laparoscopic surgical competence.

The assessment was performed using standardized operative tasks on a laparoscopic simulation platform. The GOALS instrument evaluates five dimensions: depth perception, bimanual dexterity, tissue handling, efficiency, and autonomy. Each dimension is scored on a 5-point Likert scale, where 1 indicates a marked lack of proficiency and 5 indicates proficient, standardized performance. The total score ranges from 5 to 25 points, with higher scores representing superior operative competence. Previous research has demonstrated that the GOALS scale has good construct validity and interobserver reliability for the assessment of laparoscopic skills among surgical trainees (intraclass correlation coefficient [ICC] = 0.89) [20].

Scoring was based on standardized operative videos recorded after completion of the training program. Three senior physicians who were not involved in routine teaching independently evaluated the videos while blinded to group assignments, and the mean score of the three evaluators was used as the final assessment result.

Assessment of Clinical Decision-Making Ability

Clinical decision-making ability was assessed using a structured case-based decision rating scale. Standardized clinical case materials, including medical history, physical examination findings, and auxiliary examination results, were provided to the participants. Within a limited timeframe, trainees were required to complete a diagnostic judgment, evaluate surgical indications, formulate a treatment strategy, and provide a written explanation supporting their clinical decisions.

The assessment comprised three dimensions: diagnostic accuracy, rationality of the surgical plan, and ability to identify key procedural risks. Each dimension was scored on a scale from 0 to 10, where 0 indicated an incorrect judgment or failure to make a decision, and 10 indicated an accurate judgment with clear, logical reasoning. The total score ranged from 0 to 30 points, with higher scores indicating stronger clinical decision-making ability.

Three senior physicians independently evaluated the participants according to a unified scoring standard, and the mean score was used as the final score. The internal consistency reliability of the structured case-based decision rating scale was evaluated using Cronbach's alpha coefficient. The Cronbach's alpha coefficient was 0.82, indicating good internal consistency and reliability of the assessment scale.

Evaluation of Teaching Effectiveness and Training Satisfaction

After completion of the training program, a structured teaching evaluation questionnaire was administered to investigate teaching effectiveness and trainee satisfaction. The questionnaire evaluated six dimensions: rationality of the arrangement of teaching content, applicability of the teaching method, degree of participation in practical activities, perceived improvement in clinical decision-making ability, perceived improvement in operative skills, and overall satisfaction. The internal consistency reliability of the structured teaching evaluation questionnaire was assessed using Cronbach's alpha coefficient. The Cronbach's

alpha coefficient was 0.83, demonstrating acceptable internal consistency and reliability of the questionnaire.

Each item was rated using a 5-point Likert scale, where 1 point represented "strongly disagree", and 5 points represented "strongly agree". The sum of the six items yielded a total score ranging from 6 to 30 points, with higher scores indicating greater perceived teaching effectiveness and satisfaction.

All questionnaires were completed anonymously on-site immediately after the training sessions and collected upon completion, resulting in a 100% response rate.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). For continuous variables, normality was initially assessed using the Shapiro–Wilk test. Data with a normal distribution were expressed as mean ± standard deviation ($\bar{x} \pm s$), and comparisons between groups were conducted using the independent-samples *t*-test. Data that did not conform to a normal distribution were expressed as median (interquartile range), and intergroup comparisons were performed using the Mann–Whitney *U* test. Categorical variables were expressed as frequency and percentage [n (%)]. The chi-square (χ^2) test was used for comparisons between groups when all expected frequencies were ≥5, while Fisher's exact test was used when the expected frequency was <5. All statistical analyses were two-tailed, and *p*-values < 0.05 were considered statistically significant. The reliability of the structured case-based decision rating scale and the structured teaching evaluation questionnaire was assessed using Cronbach's alpha coefficient. A Cronbach's alpha value greater than 0.70 was considered indicative of acceptable internal consistency.

Results

Comparison of Baseline Characteristics

A total of 47 resident physicians were included in this study, comprising 23 participants in the routine training group and 24 participants in the scenario-based teaching group. Baseline analysis showed no statistically significant differences between the two groups in age, duration of standardized residency training, number of completed departmental rotations, or baseline theoretical examination scores (all $p > 0.05$). Similarly, no significant differences were observed between the two groups across any dimension of the laparoscopic skills assessment, including depth perception, bimanual dexterity, efficiency, tissue handling, autonomy, or the overall GOALS total score (all $p > 0.05$). The two groups also demonstrated comparable performance in clinical decision-making indicators, including diagnostic accuracy, rationality of the surgical plan, and identification of key procedural risk points, with no statistically significant differences detected (all $p > 0.05$). Regarding categorical variables, the two groups were comparable in gender distribution, previous laparoscopic training experience, and residency training year distribution (all $p > 0.05$) (Table 1).

In summary, the two groups of trainees demonstrated good baseline comparability across demographic characteristics, theoretical knowledge, operative skills, and clinical decision-making ability, thereby providing a balanced foundation for subsequent evaluation of the intervention effects.

Comparison of Theoretical Scores and Operative Skills

After completion of the training program, participants in the scenario-based teaching group achieved significantly higher theoretical examination scores than those in the regular training group ($p < 0.05$). In terms of laparoscopic operative performance, the scenario-based teaching group demonstrated significantly superior outcomes compared with the routine training group across all five dimensions, including depth perception, bimanual dexterity, efficiency, tissue handling, and autonomy, as well as the GOALS overall score. All intergroup differences were statistically significant (all $p < 0.05$) (Table 2).

Comparison of Clinical Decision-Making Ability

After training, participants in the scenario-based teaching group obtained higher scores than those in the routine training group across all three evaluated dimensions of clinical decision-making ability, including diagnostic accuracy, rationality of the surgical plan, and identification of key procedural risk points. All differences between the groups were statistically significant ($p < 0.05$). Notably, the differences between the groups in the rationality of the surgical plan and identification of key risk points were particularly significant (both $p < 0.001$) (Table 3).

Comparison of Training Satisfaction

Post-training satisfaction assessment demonstrated that participants in the scenario-based teaching group reported significantly higher scores than those in the routine training group across all six evaluated dimensions, including rationality of content arrangement, applicability of teaching methods, participation in practical activities, perceived improvement in clinical decision-making ability, perceived improvement of operative skills, and overall satisfaction. All differences between the groups were statistically significant (all $p < 0.05$). Notably, the differences between the groups were particularly significant in the dimensions of rationality of content arrangement, participation in practical activities, and overall satisfaction (all $p \leq 0.001$). These findings suggest that trainees in the scenario-based teaching group demonstrated a more positive overall evaluation of the teaching process (Table 4).

Discussion

Gynecological laparoscopic surgery requires surgeons not only to have technical proficiency but also to accurately

Table 1. Baseline characteristics of participants in the routine training and scenario-based teaching groups.

Variables	Routine training group (n = 23)	Scenario-based training group (n = 24)	Statistic	*p*-value
Age (years)	29.00 (28.00, 30.50)	28.00 (26.00, 29.25)	$Z = 1.88$	0.060
Gender, n (%)			$\chi^2 = 0.06$	0.813
Male	6 (26.09)	7 (29.17)		
Female	17 (73.91)	17 (70.83)		
Duration of standardized training (months)	15.00 (10.50, 17.00)	12.50 (8.00, 14.25)	$Z = 1.70$	0.089
Number of completed departmental rotations	6.00 (4.00, 7.00)	4.00 (3.00, 7.00)	$Z = 1.25$	0.212
Baseline theoretical score	64.00 (62.00, 67.50)	63.50 (62.00, 67.00)	$Z = 0.32$	0.748
Baseline laparoscopic skills assessment (GOALS)				
Depth perception	2.33 (1.83, 2.67)	2.17 (1.92, 2.42)	$Z = 0.03$	0.974
Bimanual dexterity	2.00 (1.83, 2.33)	2.33 (2.00, 2.33)	$Z = 0.62$	0.533
Efficiency	2.33 (2.00, 2.33)	2.33 (1.92, 2.67)	$Z = 0.39$	0.695
Tissue handling	2.67 (2.33, 3.00)	2.33 (2.00, 2.67)	$Z = 1.19$	0.233
Autonomy	2.00 (1.83, 2.50)	1.67 (1.67, 2.08)	$Z = 1.76$	0.079
GOALS total score	11.33 (10.50, 11.83)	10.50 (10.00, 12.00)	$Z = 1.27$	0.204
Baseline clinical decision-making ability				
Diagnostic accuracy	4.67 (4.00, 5.00)	4.00 (3.67, 4.67)	$Z = 1.68$	0.094
Rationality of surgical plan	4.33 (3.67, 4.50)	3.67 (3.33, 4.67)	$Z = 0.65$	0.518
Identification of key procedural risk points	4.00 (3.33, 4.67)	4.00 (3.33, 4.42)	$Z = 0.63$	0.528
Previous laparoscopic training participation, n (%)			$\chi^2 = 0.18$	0.671
No	17 (73.91)	19 (79.17)		
Yes	6 (26.09)	5 (20.83)		
Residency training year distribution, n (%)			-	0.721
1	1 (4.35)	2 (8.33)		
2	16 (69.57)	14 (58.33)		
3	6 (26.09)	8 (33.33)		

Note: Continuous variables are presented as median (interquartile range). Categorical variables are presented as n (%). The GOALS total score represents the sum of the five assessment dimensions, with higher scores indicating better laparoscopic operative skills. GOALS, Global Assessment of Laparoscopic Skills. – indicates that Fisher's exact test was used.

Table 2. Comparison of theoretical examination scores and laparoscopic operative skills after training.

Variables	Routine training group (n = 23)	Scenario-based training group (n = 24)	Statistic	*p*-value
Theoretical examination score	69.00 (65.50, 71.00)	72.00 (67.50, 77.25)	Z = 1.99	0.047
Depth perception	2.67 (2.33, 3.00)	4.00 (3.67, 4.33)	Z = 5.86	<0.001
Bimanual dexterity	3.67 (3.00, 4.00)	4.00 (3.67, 4.33)	Z = 2.93	0.003
Efficiency	2.67 (2.17, 3.17)	4.00 (3.67, 4.42)	Z = 4.86	<0.001
Tissue handling	3.00 (2.67, 3.33)	4.00 (3.67, 4.42)	Z = 4.88	<0.001
Autonomy	3.00 (2.67, 3.33)	3.67 (3.33, 4.33)	Z = 4.51	<0.001
GOALS total score	14.67 (13.50, 16.00)	19.83 (19.25, 20.42)	Z = 5.87	<0.001

Table 3. Comparison of clinical decision-making ability between the two groups of resident physicians after training.

Variables	Routine training group (n = 23)	Scenario-based training group (n = 24)	Statistic	*p*-value
Diagnostic accuracy	5.33 (5.00, 6.33)	6.17 (5.67, 7.33)	Z = 2.35	0.019
Rationality of the surgical plan	5.33 (4.50, 6.00)	6.83 (6.25, 7.67)	Z = 4.92	<0.001
Identification of key procedural risk points	4.67 (3.67, 5.00)	7.17 (6.67, 7.67)	Z = 5.81	<0.001

execute operative procedures and make appropriate judgments at critical decision points. While resident physicians generally acquire a theoretical foundation during standardized residency training, the core challenge in surgical education is how to effectively translate theoretical knowledge into continuous, stable, and standardized operative behavior. In the present study, a scenario-based teaching program centered on the complete surgical workflow was developed and implemented. The results demonstrated that resident physicians receiving this teaching model achieved higher scores in theoretical knowledge, clinical decision-making, and operative standardization compared with those in the conventional training group, suggesting that this educational approach may contribute to improved comprehen-

Table 4. Comparison of training satisfaction between two groups of resident physicians.

Variables	Routine training group (n = 23)	Scenario-based training group (n = 24)	Statistic	*p*-value
Rationality of content arrangement	2.00 (1.00, 3.00)	3.00 (2.00, 4.25)	Z = 3.25	0.001
Applicability of teaching methods	3.00 (2.00, 4.00)	4.00 (3.00, 4.25)	Z = 2.43	0.015
Participation in practical activities	2.00 (1.50, 3.00)	3.00 (3.00, 4.00)	Z = 3.47	<0.001
Perceived improvement in clinical decision-making ability	3.00 (2.00, 3.50)	4.00 (3.00, 5.00)	Z = 2.85	0.004
Perceived improvement in operative skills	2.00 (2.00, 3.00)	3.50 (3.00, 4.25)	Z = 3.22	0.001
Overall satisfaction	2.00 (1.50, 3.00)	3.50 (3.00, 5.00)	Z = 3.88	<0.001

sive training outcomes.

In the operative skills assessment, the scenario-based teaching group not only achieved higher overall scores but also demonstrated greater advantages in operative continuity and tissue protection awareness. These findings are of practical significance. The goal of laparoscopic training extends beyond the completion of isolated technical maneuvers and includes the ability to maintain a stable, standardized, and controlled operative rhythm under conditions of restricted visual fields and limited operative space. In recent years, multiple studies have shown that structured simulation-based training can effectively improve performance in minimally invasive surgery within simulated settings, with some evidence suggesting potential transferability to real clinical practice. Zendejas et al. [21] reported in a review that systematic simulation training can improve technical stability and operative consistency. Similarly, Aggarwal et al. [22] demonstrated a clear correlation between simulation-based training models and improvements in operative safety-related behaviors.

Within the limitations of the present simulation-based assessment, the findings further suggest that embedding technical skills training within the context of the complete surgical procedure may promote more stable operative standardization. Such standardization is often reflected in a clear procedural sequence, smoother transitions between operative steps, and a more restrained use of tissue traction and energy devices. Compared with repetitive practice of isolated technical skills, process-oriented scenario-based training maintains operative behavior within an integrated clinical context, thereby providing technical actions with clearer procedural objectives and clinical relevance. The development of standardized operative behavior may therefore be facilitated by this continuous process-oriented awareness, although further evidence from real-world surgical settings is warranted to validate these effects.

Another important finding of the present study was the improvement in clinical decision-making ability. The scenario-based teaching group outperformed the control group in diagnostic judgment, surgical plan selection, and risk identification, especially in the identification of key procedural risk points. Clinical decision-making ability is fundamentally an integrative cognitive competence that is built upon knowledge acquisition but relies more on the ability to screen, prioritize, and synthesize clinical information. Previous studies have suggested that instructional models incorporating clearly structured scenarios and timely feedback mechanisms are more effective in facilitating the development of stable clinical judgment patterns among learners [23,24]. Consistent with these findings, the scenario-based teaching in this study integrated preoperative assessment, key intraoperative decision-making processes, and potential risk warnings into a unified teaching sequence, enabling learners to complete cognitive transitions within continuous clinical scenarios. This coherent experience may represent a key mechanism underlying the observed improvement in decision-making ability.

The improvement in theoretical examination scores is equally noteworthy. Although both groups received identical theoretical instruction, participants in the scenario-based teaching group achieved superior examination performance, suggesting that scenario integration may promote knowledge internalization and transfer. Within scenario-based teaching, theoretical concepts are repeatedly applied in specific scenarios, which may help learners to build a clearer knowledge network rather than relying solely on rote memorization. This scenario-based teaching approach may therefore establish a two-way reinforcement process between theoretical knowledge and clinical practice. Furthermore, the scenario-based teaching group reported significantly higher satisfaction scores. A continuous and comprehensive training experience allows trainees to more clearly perceive improvements in clinical competence, rather than simply completing isolated technical exercises. Increased participation and engagement in the teaching process may further enhance learning initiative and motivation, thereby contributing to subsequent improvement in performance.

Nevertheless, several limitations of this study should be acknowledged. First, this was a single-center study with a relatively limited sample size, which may limit the generalizability of the findings. Although statistically significant differences were observed for the primary outcomes, the limited sample size may have reduced the statistical power to detect smaller but potentially meaningful differences between the two groups. Thus, the absence of signif-

icant differences in certain baseline variables should be interpreted cautiously. Second, the evaluation indicators primarily focused on the short-term outcomes immediately after training completion, and long-term performance in real surgical settings was not assessed. Third, because of the retrospective study design, detailed information on participants' prior laparoscopic operative experience, such as the number of procedures observed or assisted and the duration of previous simulation training, was not available in the teaching management system. However, baseline GOALS scores, which objectively reflected initial operative skill levels, showed no statistically significant differences between the two groups, partially mitigating this limitation.

Fourth, several outcome measures, including GOALS scores and clinical decision-making assessments, were based on expert assessments of simulated performance rather than objective clinical outcomes such as operative duration, complication rates, or intraoperative outcomes. Although assessments were independently completed by three experienced experts and inter-rater reliability was acceptable, some degree of subjectivity is unavoidable in rating-based evaluations. Fifth, the clinical decision-making assessment tool and the teaching satisfaction questionnaire were specifically developed for this study and have not been externally validated. Future prospective, multi-center studies incorporating objective clinical endpoints and extended follow-up periods are needed to validate the associations observed in this study.

Conclusions

Overall, the findings of this study suggest that using the complete gynecological laparoscopic surgical procedure as the primary teaching framework, while integrating technical skills and decision-making through scenario-based instructional design, may be associated with simultaneous improvements in residents' operative standardization and clinical decision-making ability. This teaching model was associated with superior performance and improved understanding of operative procedures and procedural risks, which may contribute to more stable and standardized surgical practice. For residents undergoing standardized training, this process-oriented training approach may be more effective in promoting the development of comprehensive clinical competence aligned with the practical demands of gynecological laparoscopic surgery.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

XZ designed the research study. XZ and QZ performed the research. QZ analyzed the data. XZ drafted the article. Both authors contributed to the critical revision of the manuscript for important intellectual content. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Zhoukou Central Hospital (approval number: 2026-01), and all procedures followed the principles of the Declaration of Helsinki. Because this study was a retrospective analysis based on previously collected medical records and involved no additional intervention or procedures beyond routine clinical care, the requirement for informed consent was waived by the Ethics Committee.

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Conflict of Interest

The authors declare no conflict of interest.

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