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Research article

Learning curve of ultrasound-guided surgeon-administered transversus abdominis plane (UGSA-TAP) block on a porcine model

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ABSTRACT

Background: Surgeons commonly perform ultrasound-guided Transversus Abdominis Plane blocks to manage acute pain following abdominal surgeries. There is no consensus on whether surgeons should undergo basic hands-on training to perform TAP blocks or if video-based learning is sufficient. We theorized that simulation-based learning is superior to video-based learning. In the present study, we present the analysis of technical skills of UGSA-TAP block performance on a live porcine model by general surgery trainees after undergoing video or simulation-based learning.
Methods: We performed a prospective, double-blinded, randomized study. Ten surgery residents and two surgery critical-care fellows (n = 12) without prior experience in performing the TAP block were recruited. The participants were randomized either into a video-based or simulation-based training group. After that, all participants performed a TAP block on a live anesthetized pig, which was recorded and scored by three blinded anesthesiologists. All participants completed a post-performance survey to assess their confidence in gaining competency in the UGSA-TAP block. Statistical analyses were performed to assess the differences between the two groups. $P < 0.05$ was considered statistically significant.
Results: All simulation-based learning participants successfully performed a survey scan, identified the three muscular layers of the abdominal wall, and identified the transversus abdominis plane compared to 50 %, 50 %, and 33 % video-based learning group participants for the respective parameters ($p < 0.05$). While some performance metrics showed no statistically significant differences between the groups, substantial effect sizes (Cohen's h up to 1.07) highlighted notable differences in participants' performance. Both groups exhibited confidence in core competencies, with varied rates of satisfactory skill execution. Performance assessed using a global rating scale revealed a higher passing rate for the simulation group (83 % vs. 33 %).

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Participant feedback via the Likert scale reflected confidence post-training. Inter-rater reliability (0.83–1) confirmed the robustness of study evaluations.
Conclusion: The UGSA-TAP block curriculum should be introduced into the surgical residency programs with an emphasis on simulation-based learning to enhance the procedural skills of the trainees before transitioning to surgical patients.

Abbreviations

UGSA-TAP Ultrasound-guided Surgeon-Administered Transversus Abdominis Plane
Block TAP Transversus Abdominis Plane
IACUC Institutional Animal Care and Use Committee
HMRI Houston Methodist Research Institute
GRI Global Rating Item

1. Introduction

Acute pain management remains challenging for anesthesiologists and surgeons as uncontrolled acute abdominal pain is associated with increased morbidity and mortality [1,2]. Various innovative analgesia techniques are emerging for acute pain management [1]. UGSA-TAP Block is commonly performed to manage acute pain following abdominal surgeries [3–5]. Studies have demonstrated that TAP blocks lower postoperative pain scores and consumption of opioids with minimal to no adverse effects, shorten the hospital length of hospital stay, and increase patient satisfaction [5–11]. While traditionally, anesthesiologists perform regional anesthesia, there has been growing interest in the surgeon-administered fascial plane block, peripheral nerve block, and ultrasound-guided or laparoscopic-guided TAP block [6,12,13]. This may be due to many reasons, including the lack of anesthesia staff, time constraints, operating room turnover, and hospital resources [14,15].

No structured training exists for surgeons to learn regional anesthesia techniques. YouTube has been commonly used as a learning resource for surgical education amongst medical students, residents, and junior surgical faculty [16]. Moreover, the American College of Surgeons Patient Education Committee has recently started to offer a regional anesthesia skills course to train surgeons to perform TAP, pectoralis nerve block, and other fascial plane block [17]. Additionally, simulation-based training has gained significant popularity in the medical, surgical, and anesthesia world by offering a risk-free environment where trainees can safely learn and practice procedures and ultimately optimize patient outcomes [18–20]. However, there seems to be no consensus on standardized training of surgeons to learn and perform nerve block procedures. Therefore, there is a need to address the existing gaps and recommend comprehensive educational guidelines on training surgeons to perform nerve blocks safely and adequately.

To date, training specific to the performance of UGSA-TAP block has not been comprehensively discussed. Most experts now consider ultrasound guidance as the standard of care during peripheral nerve block procedures [21]. Performance of ultrasound-guided nerve block requires a triad of three distinct but interrelated skills: image acquisition, anatomical interpretation, and hand-eye coordination. Simulation-based training can improve the dynamic process needed for a successful nerve block placement by enhancing needle visualization, improving hand-eye coordination [22], decreasing technical errors, and reducing the number of needle puncture attempts [23]. There is minimal literature suggesting whether surgeons should undergo basic hands-on training to perform TAP blocks or if video-based learning is sufficient.

We hypothesize that simulation-based learning of the TAP block procedure would be superior to video-based learning. In the present study, we investigated the correct technical skills of UGSA-TAP block on a live porcine model performed by general surgery trainees after learning the TAP block technique via video on YouTube [24], NYSORA© [25] or simulation-based learning on the TAP simulator [25].

2. Methods

2.1. Study participants

We performed a prospective, double-blinded, randomized study at the Houston Methodist Institute for Technology, Innovation & Education. According to 45 CFR 46.101, a review from the institutional review board was not required. However, Houston Methodist Research Institute (HMRI) IACUC approved this study (I.D. number: ISO00006073). The number of participants was based on the resident availability and seniority level. Postgraduate year 4 residents (n = 5), postgraduate year 5 residents (n = 5), and two surgery critical care fellows (n = 2) without prior experience or any formal training in performing the ultrasound-guided regional block were recruited from a single academic institution to participate in the study. Informed consent from the participants was not required for this study because this project qualified for HMRI Institutional Review Board exemption. All participants were provided with online educational materials on the TAP block procedure (**Supplemental text**) [26]. The participants were randomized into video or simulation training groups by randomization using Microsoft Excel. Half of the recruited participants learned the TAP block technique via the video link provided to the group. The other half of the participants underwent simulation-based UGSA-TAP Block technique training. Afterward, all participants performed a TAP block on a live anesthetized pig (Fig. 1). Each study participant's video of the TAP block procedure performance was recorded (See supplemental video). Three blinded anesthesiologists evaluated the videos and scored the individual trainees' TAP block techniques. All study participants completed a survey to assess their confidence in gaining competency in ultrasound skills after the performance of the TAP block on the live porcine model.

2.2. Online education material

All participants reviewed the education material before attending the hands-on or in-person skill sessions. The participants were provided handouts outlining the TAP block procedures and corresponding links to educational videos from the NYSORA© [25] and EXPAREL_Abdominal Block Brochure 2022 (**Supplemental text**) [26]. All participants were required to complete the online modules covering various local anesthetics used for the TAP block, needle safety, positioning, and proper technique of the TAP block.

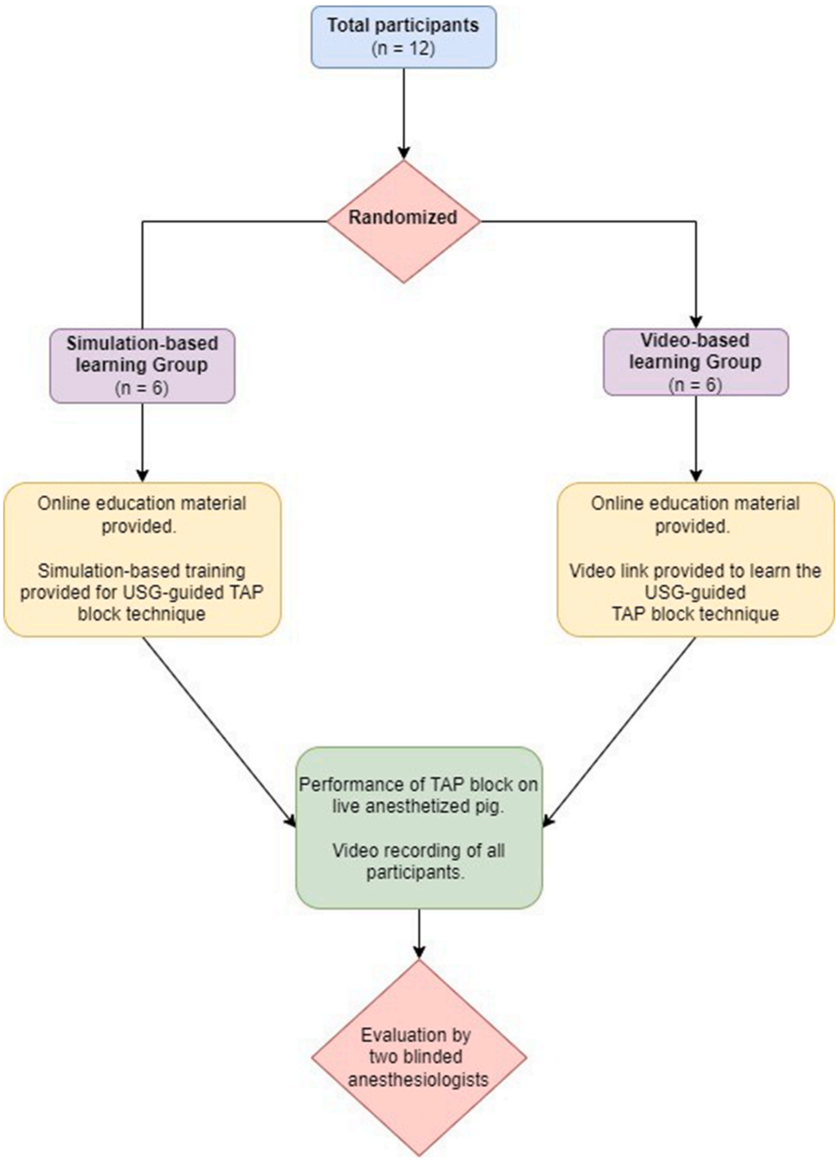

Fig. 1. Flow chart demonstrating study design.

2.3. Ultrasound-guided TAP block procedure and training

2.3.1. Video-based learning for UGSA-TAP block procedure

The video group learned the technique of TAP block by watching the video on YouTube [24], and NYSORA© website [27], which was provided to all trainees to review the US-guided approach of the TAP block.

2.3.2. Simulation-based training for UGSA-TAP block procedure

We replicated the simulator-based study design utilized by Park et al. [28] for their study. A fellowship-trained anesthesiologist led the simulation-based training session on the technique of TAP nerve block on CAE health care TAP block simulation mannequins [25] (Fig. 1). The training on the mannequin was conducted for one hour, and all trainees were encouraged to learn and participate. Participants then went on to perform on the swine. Practicing the TAP block on the CAE health care TAP simulator [25], allowed participants to practice the selection of the correct ultrasound transducer, appropriate positioning of the probe, visualization of the transversus abdominis planes, and proper needle placement and trajectory before the performance of the TAP block on live animal tissue.

2.3.3. Animal preparation

All procedures were approved and performed per the local IACUC and Animal Guidelines. A veterinary anesthesiologist and veterinary anesthesia technician performed all anesthesia-related procedures on swine. We administered anesthesia to two pigs, each weighing between 50 and 65 kg, using a combination of intravenous ketamine at a dosage of 20 mg/kg and intravenous midazolam at 0.3 mg/kg. The intravenous propofol at a dosage of 2.5 mg/kg was administered after ensuring the pigs were preoxygenated using a standard animal mask, delivering oxygen at a rate of 6 L per minute. Post-intubation, we maintained anesthesia using a mixture of 2 % isoflurane and oxygen, delivered at a flow rate of 2 L per minute through mechanical ventilation. The ventilator settings were continually adjusted to keep the end-tidal carbon dioxide levels within the range of 35–45 mmHg for the duration of the experiment. The study participant performed the TAP block on one side of the swine per the direction of the research team member, and the TAP block was performed serially. The right and left sides were also alternated per every participant per animal.

2.3.4. UGSA-TAP block procedure on live porcine model

All the participating trainees alternately performed the TAP block on an anesthetized swine's right and left hemiabdomen in the supine position. A preliminary survey scan of the overall abdomen was conducted to detect any gross abnormality for abscess, tumor, and hematoma, which was a contraindication to performing the TAP block. We positioned a high-frequency linear ultrasound probe, operating at 5–10 MHz, transversely along the lateral side of the abdomen, specifically between the lower edge of the ribcage and the top of the iliac crest. This setup allowed us to clearly visualize the various abdominal layers from the skin surface down to the peritoneum, including the subcutaneous layer, fat tissue, and the abdominal muscles, such as the external and internal obliques and the transversus abdominis. Under real-time ultrasound guidance, we inserted needles in the same plane as the probe, directing them precisely to the space between the internal oblique and transversus abdominis muscles. Next, 2 mL of saline was injected to confirm the correct needle position (hydrolocation). Subsequently, 10 mL of saline was injected to visualize the expansion and spread of saline in the transversus abdominis plane, which we described as the "effectiveness of the TAP block."

2.3.5. Post-procedure evaluations

Three anesthesiologists blindly evaluated a distinct set of study participants' TAP block procedure performance in recorded videos. Candidates were assessed based on the evaluator's review of their performance and also rated by the 19-item Ultrasound Guided Regional Anesthesia Competency Assessment Tool [29,30] and the 5-item Global Rating Item (GRI) checklist, which includes various parameters rated on a scale of 1–5 with one being the worst and five as the best [31]. The reviewers assessed the success of the procedure involving the visualization and identification of the different muscle planes, the peritoneum, the tip of the needle, an evaluation of the effectiveness of the block (spread and expansion of Saline in TAP), the absence of intervention from the supervisor, the lack of complications (e.g., post-procedure hematoma), less than three attempts, and a satisfaction score of seven by the supervisor on a 0–10 rating scale. Pass/Fail evaluation was based on the reviewers' ratings, the GRI checklist, and the Ultrasound Guided Regional Anesthesia Competency Assessment Tool.

2.3.6. Post-procedure survey

All study participants were given confidential questionnaires to subjectively assess their overall knowledge and confidence in the performance of the UGSA-TAP Block procedure. The participants rated each question on a 5-point Likert scale (1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high). The questions asked in surveys were as follows.

1. Confidence in Ultrasound Knobology required for TAP Block
2. Confidence in the use of probe required for peripheral nerve block, specifically TAP Block
3. Confidence in identifying layers of the abdominal wall required for TAP Block
4. Confidence in the identification of the transversus abdominis plane.
5. Confidence in the identification of insertion of needle between the internal block and transversus abdominis muscle
6. Confidence in performing ultrasound-guided TAP block

2.3.7. Statistical analysis

Survey parameters of the ultrasound skills and regional anesthesia competency assessment tool were tabulated by the category of the participating groups: Simulation or video-based TAP learning. Participants' performances were evaluated using a 19-item Competency Tool (graded as 'satisfactory' or 'unsatisfactory'), a 5-item Global Rating Item (GRI) checklist (scored from 1 to 5), and a Likert-scale participant survey on perceived knowledge gain. The chi-square or Fischer exact tests were used to assess differences in categorical distributions across these tools. Statistical analyses were performed by Stata (version 17.0, StataCorp, College Station, TX). We considered a $p < 0.05$ to be statistically significant. Effect sizes were calculated using Cohen's *h* to determine the effect sizes between the two groups. Examiner 1 and Examiner 2 assessed different subsets of participants with no overlap. Examiner 3 was added to evaluate all participants to determine reliability via the Intraclass Correlation Coefficient (ICC) calculation for all parameters using the mixed-effects model.

Table 1
Participants' performance assessment based on the Ultrasonography Regional Anesthesia Competency Assessment Tool.

	Total	*Video-based*	*Simulation-based*	*p-value*
	N = 12	N = 6	N = 6	
USG Regional Anesthesia Competency Assessment Tool				
USG guided TAP block technique- Checklist				
Selection of correct transducer probe				
1. Satisfactory	12 (100 %)	6 (100 %)	6 (100 %)	
Correct setting for depth and gain				0.22
1. Satisfactory	8 (67 %)	3 (50 %)	5 (83 %)	
2. Unsatisfactory	4 (33 %)	3 (50 %)	1 (17 %)	
Appropriate holding of probe				1.00
1. Satisfactory	10 (83 %)	5 (83 %)	5 (83 %)	
2. Unsatisfactory	2 (17 %)	1 (17 %)	1 (17 %)	
Orientation of ultrasound screen with sides of the probe				
1. Satisfactory	12 (100 %)	6 (100 %)	6 (100 %)	
Performs survey scan, identifies structures pertinent to the procedure				**0.046**
1. Satisfactory	9 (75 %)	3 (50 %)	6 (100 %)	
2. Unsatisfactory	3 (27 %)	3 (50 %)	0 (0 %)	
Correct identification of anatomy and target				0.079
1. Satisfactory	7 (58 %)	2 (33 %)	5 (83 %)	
2. Unsatisfactory	5 (42 %)	4 (67 %)	1 (17 %)	
Identify three muscular layers of the abdominal wall during ultrasound scanning				**0.046**
1. Satisfactory	9 (75 %)	3 (50 %)	6 (100 %)	
2. Unsatisfactory	3 (25 %)	3 (50 %)	0 (0 %)	
Optimizes target image by probe manipulation if necessary				0.22
1. Satisfactory	8 (67 %)	3 (50 %)	5 (83 %)	
2. Unsatisfactory	4 (33 %)	3 (50 %)	1 (17 %)	
Identify transversus abdominal plane				**0.014**
1. Satisfactory	8 (67 %)	2 (33 %)	6 (100 %)	
2. Unsatisfactory	4 (33 %)	4 (67 %)	0 (0 %)	
Chooses appropriate needle insertion point trajectory to maintain in-plane ultrasound views				0.50
1. Satisfactory	9 (75 %)	5 (83 %)	4 (67 %)	
2. Unsatisfactory	3 (25 %)	1 (17 %)	2 (33 %)	
Recognition of proper needle position				0.56
1. Satisfactory	7 (58 %)	4 (67 %)	3 (50 %)	
2. Unsatisfactory	5 (42 %)	2 (33 %)	3 (50 %)	
Needle alignment to probe				0.50
1. Satisfactory	9 (75 %)	4 (67 %)	5 (83 %)	
2. Unsatisfactory	3 (25 %)	2 (33 %)	1 (17 %)	
Ability to maintain view of needle				1.00
1. Satisfactory	8 (67 %)	4 (67 %)	4 (67 %)	
2. Unsatisfactory	4 (33 %)	2 (33 %)	2 (33 %)	
Ability to locate needle tip in real time, throughout procedure				1.00
1. Satisfactory	8 (67 %)	4 (67 %)	4 (67 %)	
2. Unsatisfactory	4 (33 %)	2 (33 %)	2 (33 %)	
Perform appropriate needle tip adjustment if needed				0.079
1. Satisfactory	7 (58 %)	2 (33 %)	5 (83 %)	
2. Unsatisfactory	5 (42 %)	4 (67 %)	1 (17 %)	
Visualization of needle tip prior to injection				1.00
1. Satisfactory	10 (83 %)	5 (83 %)	5 (83 %)	
2. Unsatisfactory	2 (17 %)	1 (17 %)	1 (17 %)	
Recognizes spread of local anesthesia and adjusts needle positioning				0.56
1. Satisfactory	5 (42 %)	2 (33 %)	3 (50 %)	
2. Unsatisfactory	7 (58 %)	4 (67 %)	3 (50 %)	

3. Results

Our study population consisted of 12 participants, randomized into two groups: simulation-based and video-based TAP block learning group and performance of TAP block on live anesthetized pig followed by evaluation of the technique by three reviewer anesthesiologists. When assessing the ultrasound-guided TAP block technique, all the participants were satisfactorily able to select the correct transducer probe and have the correct orientation of the ultrasound screen with the probe. When comparing Examiner 1 and Examiner 3, as well as Examiner 2 and Examiner 3, the ICC values ranged from 0.83 to 1 (CI O.5–0.99), indicating excellent reliability and affirming the robustness of our findings.

Table 1 describes the performance of the TAP block between the two groups. Compared to the video-based learning group, 83 % of the simulation-based learning group performed the following tasks satisfactorily: correct setting for depth and gain ($p = 0.22$), accurate identification of anatomy and target ($p = 0.079$), target image optimization by adequate ultrasound probe manipulation ($p = 0.22$), proper needle alignment to probe ($p = 0.50$) and tip adjustment ($p = 0.079$). In contrast, for the same parameters, the video-based group's satisfactory performance rate was 50 % for the correct setting for depth and gain, 33 % for accurate identification of anatomy and target, 50 % for target image optimization by adequate ultrasound probe manipulation, 67 % for proper needle alignment to probe and 33 % tip adjustment. While the results were not statistically significant ($p > 0.05$), the effect size for the difference in proportions of participants performing correctly between the two groups for the correct setting for depth and probe manipulation, as quantified by Cohen's h, was 0.73, suggesting a substantial difference. Similarly, for correct anatomic identification and needle tip adjustment, Cohen's h was calculated to be 1.07, showing a higher proportion of participants in the simulation-based learning group performing the task correctly than the video-based learning group despite the lack of statistical significance.

All simulation-based learning participants successfully performed a survey scan ($p < 0.05$), identified the three muscular layers of the abdominal wall ($p < 0.05$), and identified the transversus abdominis plane ($p = 0.014$) compared to 50 %, 50 %, and 33 % video-based learning group participants for the respective parameters. These performance parameters were statistically significant, indicating better performance metrics in the simulation-based learning group. Two-thirds of both groups were able to maintain the view of the needle and locate the needle tip in real-time throughout the procedure, and 83 % in both groups were able to visualize the needle tip before injection and hold the probe appropriately ($p > 0.05$). In the video-based learning group, 67 % recognized the proper needle position compared to 50 % in the simulation-based group ($p = 0.56$). Additionally, 83 % in the video-based groups chose a needle

Table 2
Participants' performance assessment based on the Global Rating Item.

Global Rating Item	Total	Video-based	Simulation-based	p-value
	N = 12	N = 6	N = 6	
Aseptic technique as possible				**0.014**
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	0 (0 %)	0 (0 %)	0 (0 %)	
4	8 (67 %)	2 (33 %)	6 (100 %)	
5	4 (33 %)	4 (67 %)	0 (0 %)	
Respect for tissue				0.30
1	1 (8 %)	1 (17 %)	0 (0 %)	
2	1 (8 %)	0 (0 %)	1 (17 %)	
3	0 (0 %)	0 (0 %)	0 (0 %)	
4	6 (50 %)	2 (33 %)	4 (67 %)	
5	4 (33 %)	3 (50 %)	1 (17 %)	
Time and motion				0.21
1	1 (8 %)	1 (17 %)	0 (0 %)	
2	1 (8 %)	0 (0 %)	1 (17 %)	
3	0 (0 %)	0 (0 %)	0 (0 %)	
4	8 (67 %)	3 (50 %)	5 (83 %)	
5	2 (17 %)	2 (33 %)	0 (0 %)	
Instrument handling				0.28
1	1 (8 %)	1 (17 %)	0 (0 %)	
2	2 (17 %)	1 (17 %)	1 (17 %)	
3	0 (0 %)	0 (0 %)	0 (0 %)	
4	5 (42 %)	1 (17 %)	4 (67 %)	
5	4 (33 %)	3 (50 %)	1 (17 %)	
Flow of procedure				0.57
1	1 (8 %)	1 (17 %)	0 (0 %)	
2	2 (17 %)	1 (17 %)	1 (17 %)	
3	0 (0 %)	0 (0 %)	0 (0 %)	
4	6 (50 %)	2 (33 %)	4 (67 %)	
5	3 (25 %)	2 (33 %)	1 (17 %)	
Overall candidate performance				0.079
Pass	7 (58 %)	2 (33 %)	5 (83 %)	
Fail	5 (42 %)	4 (67 %)	1 (17 %)	

insertion point trajectory that maintained in-plane ultrasound views, in contrast to 67 % in the simulation-based group (p = 0.50). Regarding recognition of the spread of injectate and needle position adjustment, 50 % of the simulation-based learning group performed satisfactorily compared to 33 % of the video-based learning group participants (p = 0.56).

Table 2 depicts the participant performance of the two groups, evaluated by the global rating scale. All the participants were able to follow the aseptic technique (p = 0.014). 83 % of the participants in both groups respected the tissue integrity (83 %) (p = 0.30) and time and motion (83 %) (p = 0.21). The performance of instrument handling and flow of the procedure was graded satisfactorily in 84 % of the simulation-based learning group compared to 67 % of the video-based learning group (p = 0.28)). Overall, candidate performance was assessed by a pass or fail score where 83 % of the simulation-based TAP block learning group passed compared to 33 % of the video-based TAP block learning group (p = 0.079). Contradictory to lack of statistical significance, Cohen's h was calculated to be 1.07, indicating a large effect size.

Table 3 highlights the feedback received from the study participants on a Likert scale about the skills' competency after training and performing the TAP block on the porcine model. Participants in both groups were equally confident in using the probe required for the TAP block technique ($p > 0.05$), identification of transversus abdominis plane (p = 0.29), and performing the ultrasound-guided TAP block procedure (p = 0.79). Between the simulation-based versus video-based learning groups, the following proportions of participants gave a Likert rating of 4–5 for the following skills: ultrasound knobology usage for TAP block (100 % vs 67 %) (p = 0.29), identification of layers of the abdominal wall (84 % vs. 100 %) (p = 0.34), and for identification of needle insertion between the internal oblique and transversus abdominis muscle (83 % vs. 84 %) (p = 0.29).

4. Discussion

Traditionally, regional anesthesia is performed by the anesthesiologist. Nowadays, peripheral nerve block, particularly fascial plane block for acute pain management, is increasingly performed by surgeons. UGSA-TAP block is an innovative procedure in general

Table 3
Survey of participants' responses.

	Total N = 12	Video-based N = 6	Simulation-based N = 6	p-value
Ultrasound Skill Competencies				
Confidence in Ultrasound Knobology required for TAP Block				0.29
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	2 (17 %)	2 (33 %)	0 (0 %)	
4	2 (17 %)	1 (17 %)	1 (17 %)	
5	8 (67 %)	3 (50 %)	5 (83 %)	
Confidence in use of probe required for peripheral nerve block, specifically TAP				1.00
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	2 (17 %)	1 (17 %)	1 (17 %)	
4	2 (17 %)	1 (17 %)	1 (17 %)	
5	8 (67 %)	4 (67 %)	4 (67 %)	
Confidence in identifying layers of the abdominal wall required for TAP Block				0.34
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	1 (8 %)	0 (0 %)	1 (17 %)	
4	4 (33 %)	3 (50 %)	1 (17 %)	
5	7 (58 %)	3 (50 %)	4 (67 %)	
Confidence in the identification of transversus abdominal plane				0.17
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	2 (17 %)	1 (17 %)	1 (17 %)	
4	5 (42 %)	4 (67 %)	1 (17 %)	
5	5 (42 %)	1 (17 %)	4 (67 %)	
Confidence in the identification of insertion of needle between the internal block and transversus abdominis muscle				0.43
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	2 (17 %)	1 (17 %)	1 (17 %)	
4	6 (50 %)	4 (67 %)	2 (33 %)	
5	4 (33 %)	1 (17 %)	3 (50 %)	
Confidence in performing ultrasound-guided TAP block				0.79
1	0 (0 %)	0 (0 %)	0 (0 %)	
2	0 (0 %)	0 (0 %)	0 (0 %)	
3	2 (17 %)	1 (17 %)	1 (17 %)	
4	7 (58 %)	4 (67 %)	3 (50 %)	
5	3 (25 %)	1 (17 %)	2 (33 %)	

surgery [32]. However, no standardized educational modules exist that incorporate these techniques into surgical residency programs. Furthermore, literature describing the learning techniques on the surgeon-administered fascial plane and peripheral nerve blocks is sparse. Therefore, we sought to evaluate different learning modalities of nerve blocks performed by surgical trainees and evaluate their respective effectiveness by investigating the learning curve of simulation-based vs. video-based learning of the TAP block procedure.

Our study results found several differences between the two groups regarding the learning curve and performance of the TAP block. Overall, the performance of the simulation-based learning group was better than the video-based learning group on almost all parameters included in the competency assessment tool checklist. Intuitively, the simulation-based learning group's better performance than the video-based learning group is apparent as hands-on training incorporates better learning than visual education [33]. The CAE healthcare TAP block simulator [25] was able to equip trainees better to gauge the correct setting for depth and gain, optimize probe manipulation, needle alignment, and tip adjustment, and adequately identify the correct target and anatomic planes and layers. As these are the major factors in performing regional anesthesia, the discrepancy in learning modalities and patient safety implications is quite concerning. It demonstrates that video-based learning alone cannot be not enough while simultaneously highlighting the promising potential of simulation-based learning of fascial plane blocks performed by surgeons. The majority (83 %) of the simulation-based TAP block learning group passed the assessment compared to only (33 %) of the video-based TAP block learning group, showcasing that simulation-based learning can significantly impact learner capabilities (Table 2). Similarly, several studies have assessed simulation-based learning and found it compelling due to significantly improving the trainee's comfort level and confidence/success, which further supports the efficacy of simulation-based surgical education [34–36].

Despite only undergoing a single training session, the improved performance of the simulation-based learning group exemplifies how such training can allow surgeons to practice and gain confidence in administering this technique and make an invaluable difference to the overall learning curve [28]. Post-assessment confidence scores based on the Likert scale demonstrated that the simulation-based learning group was more confident with most skills than the video-based learning group. Moreover, the video-based learning group may be less comfortable performing the procedure independently due to a lack of the hands-on experience the simulator may provide. Familiarity with nerve blocks because of lack of practice and foundational knowledge are typically the main factors contributing to trainee discomfort in independently performing the TAP block [28,34,35]. Furthermore, simulation-based education may provide a greater depth of learning and ensure better trainee engagement, resulting in better post-training outcomes.

While there are significant differences in the two groups' performance, video-based education can still be fruitful. In a study by Twefik et al. video education in the instruction of regional anesthesia has shown clear benefits of video modules [17]. Although the simulation group performed markedly better than the video group, the video group demonstrated improvement in line with that expected when trained via video [17,35].

Similar to previously published studies on measuring the efficacy of video-based education on physician confidence and competence [17]. Our results suggest that video-based education may somewhat improve physician confidence in performing TAP blocks independently. Support for this statement stems from the literature suggesting that surgeon competency may improve, but only when high-quality educational videos are used instead of poor-quality sources such as YouTube [17]. In this study, the high quality of video education NYSORA© [24-25] may have contributed to improved performance. However, video-based learning still does not match the gold standard of simulation-based or hands-on education.

UGSA-TAP block is a viable concept. The increasing popularity of the UGSA-TAP block can be attributed to the confidence of the trainee surgeons in performing the fascial plane block, which is well known to be safe either performed by an anesthesia or non-anesthesia provider [36]. Our study recommends that education and training on TAP block are necessary for surgeons interested in performing the UGSA-TAP block. Undoubtedly, surgeons should undergo training before performing this procedure independently to ensure improved skills and learning for the trainees and future consultants and better patient outcomes.

5. Limitations

We recognize that our study has some limitations. First, our sample cohort was small and derived from a single institution. However, the preliminary results show appreciable differences and future studies should warrant a multi-centered study. Secondly, even though both groups received similar study materials, a prior baseline knowledge assessment was not conducted and may have impacted performance.

6. Conclusion

The UGSA-TAP block curriculum should be introduced into the general surgery residency programs. Simulation-based TAP block learning will hone the clinical hands-on training skills of the trainees and ensure a good command of performing the TAP block before transitioning to surgical patients. Future research directions include the conduction of the study with more trainees and at multiple institutions, as well as the creation of additional modules to optimize the educational framework.

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Data availability statement

Data will be made available on request.

Ethics statement

Houston Methodist Research Institute (HMRI) IACUC approved this study (I.D. number: ISO00006073). Informed consent from the participants was not required for this study because this project qualified for HMRI Institutional Review Board exemption, and participation was voluntary.

Abbreviated title

UGSA-TAP Block.

Summary statement

Ultrasound-guided surgeon-administered TAP block is becoming increasingly common. We investigated the performance of UGSA-TAP block on a live porcine model by general surgery trainees after video or simulation-based learning. Simulation-based learning yielded superior results.

Prior presentations

None.

CRediT authorship contribution statement

H. Faisal: Writing – original draft, Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **F. Qamar:** Writing – original draft, Writing – review & editing, Visualization, Validation, Software, Methodology, Formal analysis. **S. Martinez:** Writing – original draft, Supervision, Resources, Project administration. **S.E. Razmi:** Writing – original draft. **R.J. Oviedo:** Writing – original draft, Validation, Supervision, Resources, Project administration. **F. Masud:** Writing – original draft, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25006.

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