Building Ultrasound-Guided Procedure Skills in Regional Anesthesia Via Simulation Training with a Formalin-embalmed Cadaver Model

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Objective: Assess the feasibility of utilizing formalin-embalmed cadavers for ultrasound-guided femoral nerve block training

Background

- Femoral nerve blocks are valuable for anesthesia and pain control in lower extremity procedures.
- Training opportunities are limited and practicing on live patients carries risks.
- Current simulation models (phantoms, fresh-frozen cadavers) have limitations in cost, availability, or anatomical realism.
- Formalin-embalmed cadavers are widely available in anatomy labs but rarely used for ultrasound-guided procedures.

Methods

Participants: 19 first-year medical students

Training:

15-min video on ultrasound-guided femoral nerve block.

- 20-min one-on-one hands-on practice on formalin-embalmed cadavers alongside an experienced instructor
- The goal was to identify femoral nerve, artery, vein, fascia lata, fascia iliaca and conduct needle guidance into target zone (no injection).

Assessment:

- Pre/post confidence surveys using a 5-point Likert scale
- 5-min skills test evaluating success at needle guidance, number of attempts, time to completion
- Ultrasound image clarity of relevant structures.

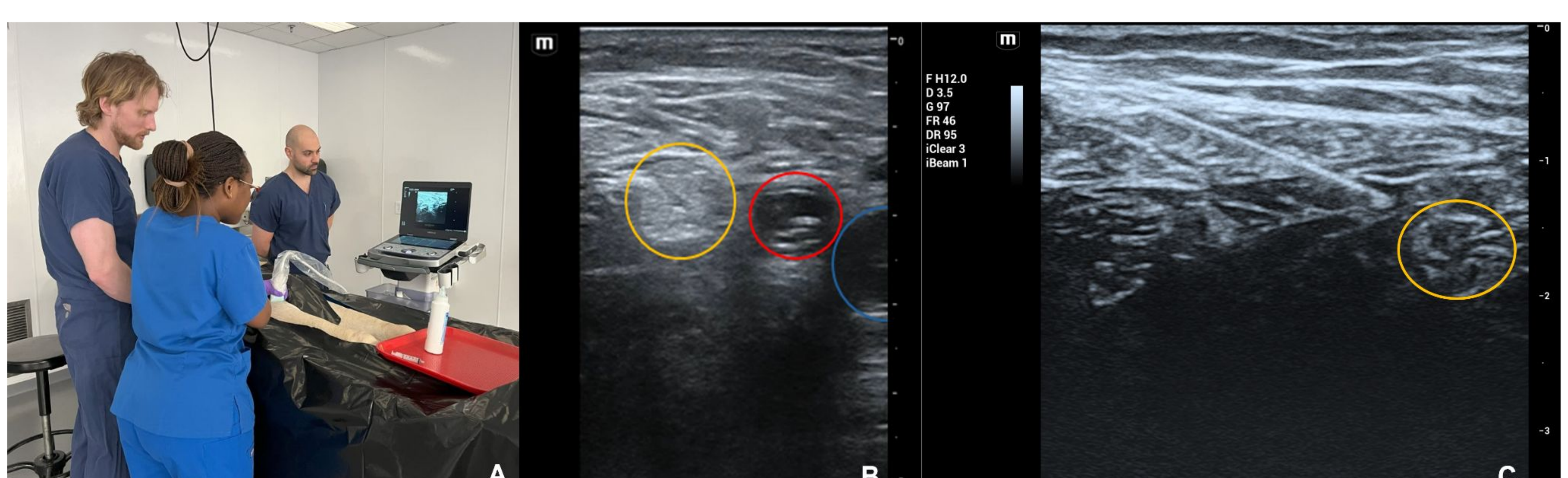

Figure 1. Simulation training and ultrasound images of the formalin-embalmed Femoral triangle

Results

- Ultrasound imaging in formalin-embalmed cadavers clearly visualized all key structures, including the femoral nerve, artery, vein, fascia lata, fascia iliaca, and the needle.
- Participant self-confidence increased significantly across all aspects of the procedure after training ($p < 0.001$), with 89.5% rating the cadaver simulation as "quite" or "extremely useful" for their own skill development.
- During the 20-minute training session, participants guided the needle into the target zone an average of 5 times, and 18 out of 19 successfully completed the post-training skills assessment.
- Participants completed the skills test in an average of 106 seconds using 1.9 needle attempts, and higher Global Rating Scale scores correlated with greater perceived usefulness of the simulation training ($p < 0.05$).

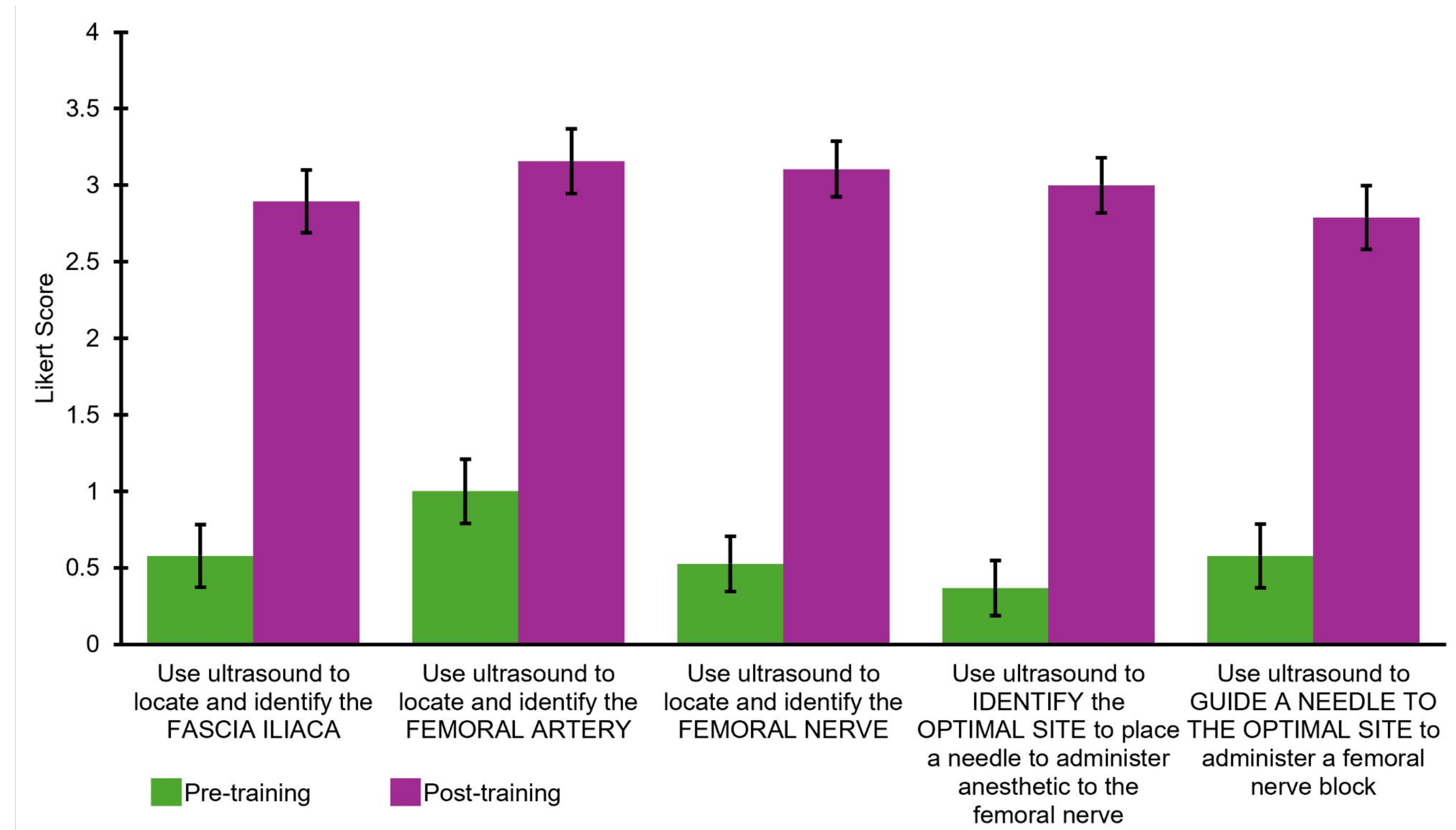

Figure 2. Participant self-confidence assessment pre and post-training

Variable	N	Mean	Std Dev	Minimum	Maximum
Respect for tissue	19	4.578947	0.837708	2	5
Time and motion	19	4.368421	0.955134	2	5
Instrument handling	19	4.157895	0.95819	2	5
Flow of procedure	19	4.210526	0.976328	2	5
Knowledge of procedure	19	4.526316	0.841191	2	5
Overall performance	19	4.210526	0.976328	2	5
Procedures completed during training	19	5	2.2	2	11
Time to complete procedure	19	106.4 sec	64.4 sec	33 sec	240 sec
Attempts needed to complete procedure	19	1.9	1.3	1	6

Figure 3. Skill performance descriptive analysis of study participant performance during a femoral nerve block needle placement skills test as recorded by instructors.

Conclusions

- Formalin-embalmed cadavers provide sonographically clear images and are suitable for teaching femoral nerve blocks.
- Early exposure to ultrasound-guided procedures via cadaver simulation may help learners gain confidence and ensure patient safety
- Future studies could include larger cohorts and better assess how these skills transfer clinically

Skill assessment response variable	Number of procedures completed			Instructor (average estimate of 4 instructors)			Time to comprete procedure (Seconds)			Attempts needed to complete procedure			Used US before		
	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value	Estimate	Standard Error	P-value
Respect for tissue	0.034	0.092	0.7141	-0.179	0.565	0.7352	0.000	0.003	0.9479	-0.398	0.125	0.0055*	-0.500	0.529	0.3574
Time and motion	0.102	0.102	0.3291	-0.015	0.671	0.9997	-0.010	0.003	0.0010*	-0.244	0.170	0.1699	-0.354	0.612	0.5706
Instrument handling	0.159	0.098	0.1221	-0.348	0.614	0.4143	-0.008	0.003	0.0172*	-0.258	0.170	0.1464	-0.208	0.618	0.7403
Flow of procedure	-0.011	0.107	0.9167	0.300	0.665	0.8125	-0.006	0.003	0.0714	-0.422	0.153	0.0134*	0.250	0.629	0.6960
Knowledge of procedure	0.114	0.088	0.2142	-0.119	0.583	0.9393	-0.008	0.002	0.0035*	-0.334	0.136	0.0255*	-0.563	0.527	0.3009
Overall performance	0.011	0.107	0.9167	0.156	0.667	0.8299	-0.009	0.003	0.0114*	-0.422	0.153	0.0134*	-0.146	0.631	0.8200

Figure 4. Associations between participant skill performance score as measured by instructors using the global rating scale rubric versus participant performance metrics. Significant associations are indicated with an asterisk

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