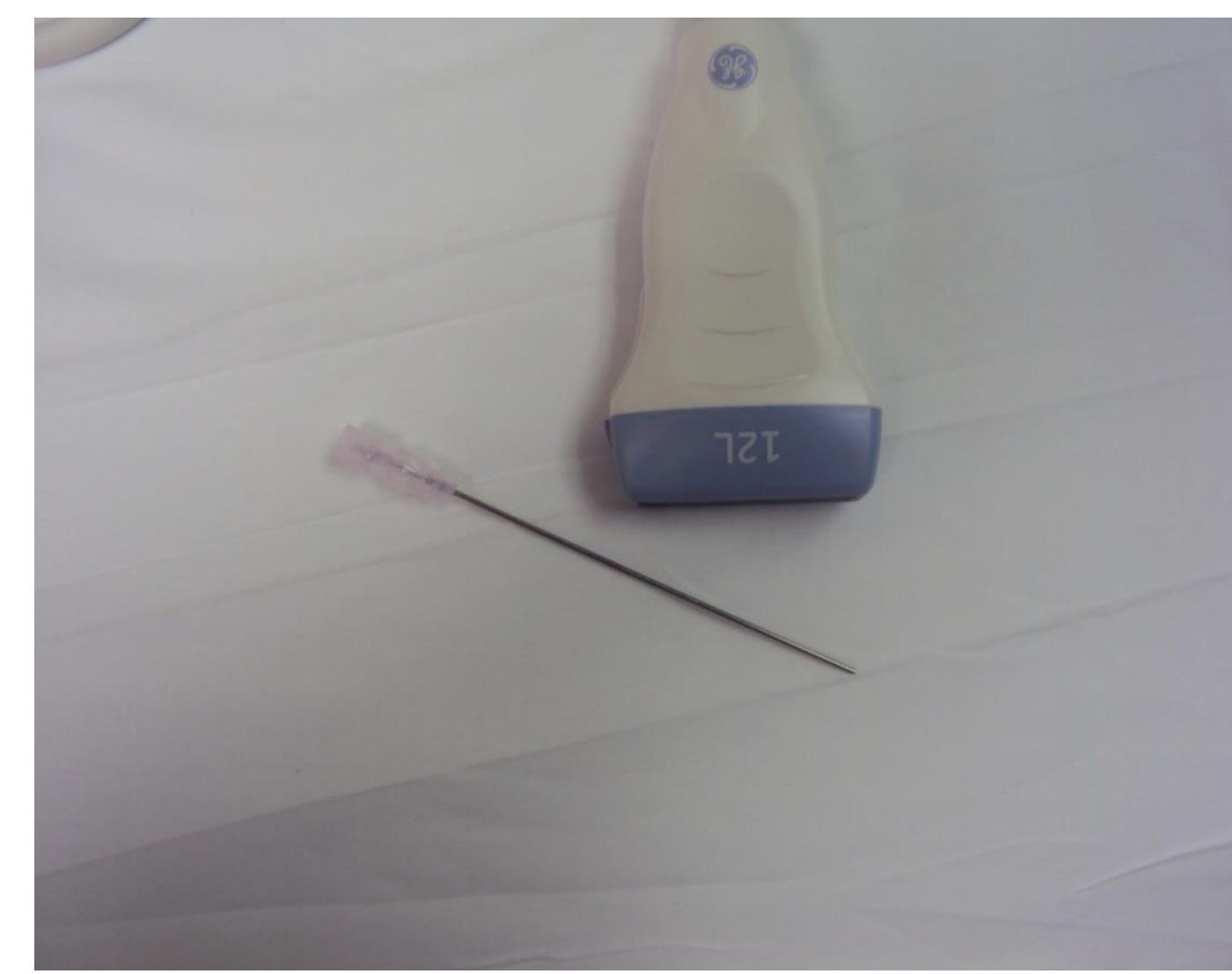


INTRODUCTION

- Ultrasound guided needle placement is a widely used technical skill but it is difficult to learn.
- Currently, there is no evidence based, standardized approach to performing or teaching ultrasound guided musculoskeletal interventions. This presents a challenge to physicians who are tasked with teaching these procedures to novices. This challenge manifests as beginners struggle with both efficiency and accuracy when learning to perform ultrasound guided procedures.
- Technological innovations such as needle guides, laser guidance, and robotics improve performance time and accuracy but the high cost associated with these technologies limit their widespread implementation.
- Our objective was to determine if giving novices predefined angles would improve performance time and accuracy when learning and performing ultrasound guided procedures.
- A secondary objective was to determine whether participants thought the APPLES (approach, position, perpendicular, lift, entry, sweep) mnemonic was a helpful guide for performing the procedure.

STUDY MEASURES

In Plane Approach



Out of Plane Approach

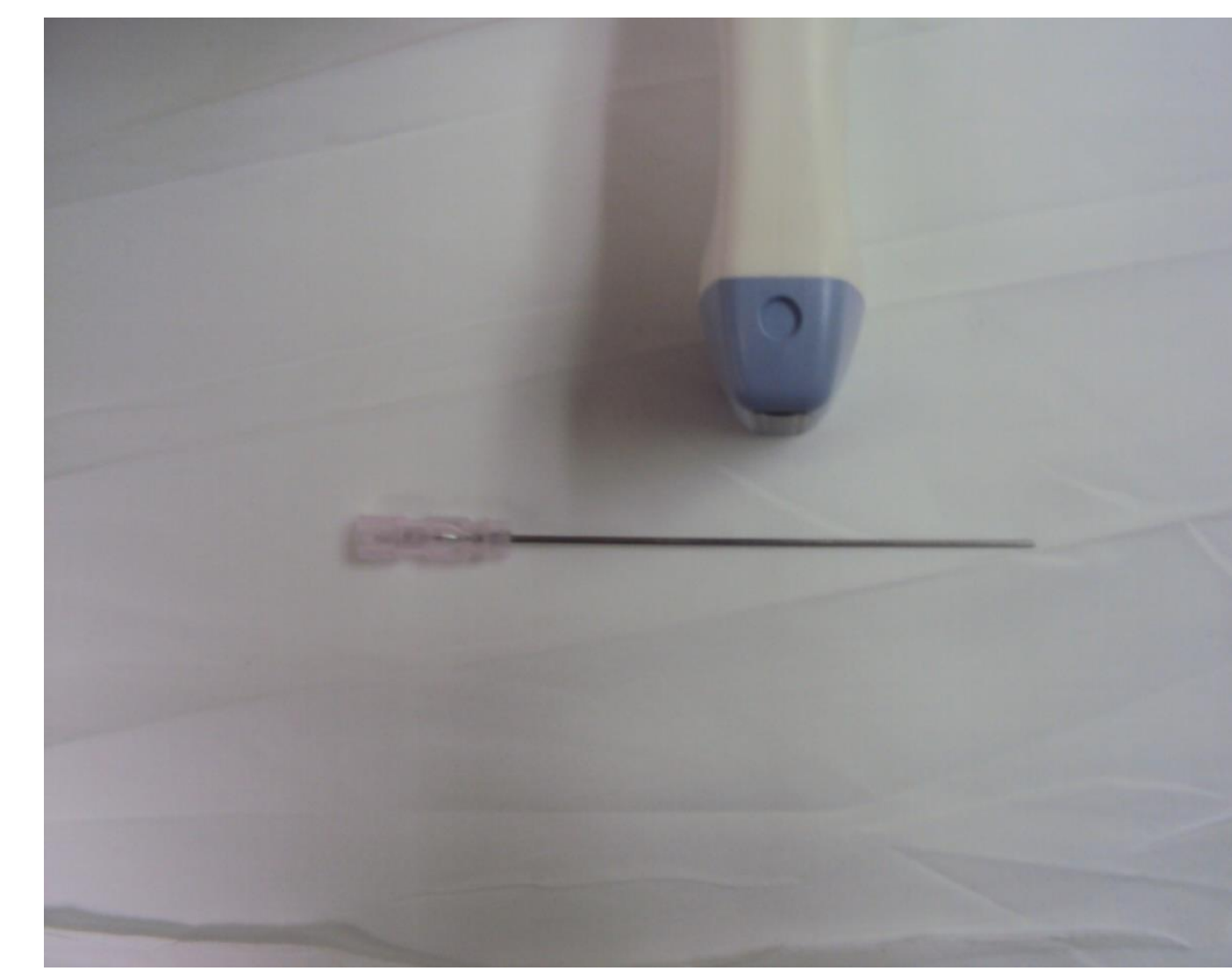


Figure 3: Intervention Approaches

MATERIALS & METHODS

- Participants were medical students, residents, and practicing physicians with 6 or fewer ultrasound-guided procedures. Procedures were performed on a gel mold with simulated nerves using a Logic E ultrasound machine with a 12 MHz transducer to visualize the needle. The target structure was a simulated nerve at either a depth of 1 cm or 3 cm.
- Participants were randomized into 4 groups, stratified by method and depth of target (Figure 1), and given instructions on how to position the needle and transducer during their attempt.
- The two methods for ultrasound guided procedures include an in plane approach and an out of plane approach.
- For the second trial, each participant crossed over to the other method and target depth and was given an approach angle and a distance from the probe to insert the needle (Figure 2). For both trials, the participant had 15 seconds to hit the target.
- Videos of each attempt were reviewed by 2 blinded physicians to determine accuracy and time to target. Any disagreement was resolved by consensus.
- After both trials, the participants were explained the APPLES mnemonic and asked to complete a survey indicating if they thought the mnemonic would be helpful when learning both methods for ultrasound guided procedures.
- An additional survey was utilized to determine if the participants thought that the predefined angles were useful in learning ultrasound guided procedures. A Mann-Whitney U test was used to compare performance times and a Fisher's Exact test was used to compare accuracy.

Group	A	B	C	D
Trial 1	1cm Out of plane	1cm In plane	3cm Out of plane	3cm In plane
Trial 2	3cm In plane with angles	3cm Out of plane with angles	1cm In plane with angles	1cm Out of plane with angles

Figure 1: Study Groups

Depth of Target	Out of plane		In plane	
	Angle	Distance from probe	Angle	Distance from probe
1 cm	45°	0.5 cm	20°	0.5 cm
3 cm	45°	2.5 cm	45°	0.5 cm

Figure 2: Predefined angles

RESULTS

Statistical analyses were performed using IBM SPSS Statistics 25.0.

Table 1: Statistical Analysis of Data

Fisher's Exact test comparing accuracy

Depth/Approach	Miss, no angles	Hit, no angles	Miss, angles	Hit, angles	p-value
1 cm out of plane	6	23	1	29	0.052
1 cm in plane	15	15	14	16	1
3 cm out of plane	20	10	13	17	0.119
3 cm in plane	10	20	2	27	0.021

1 = Trial without angles
 2 = Trial with angles

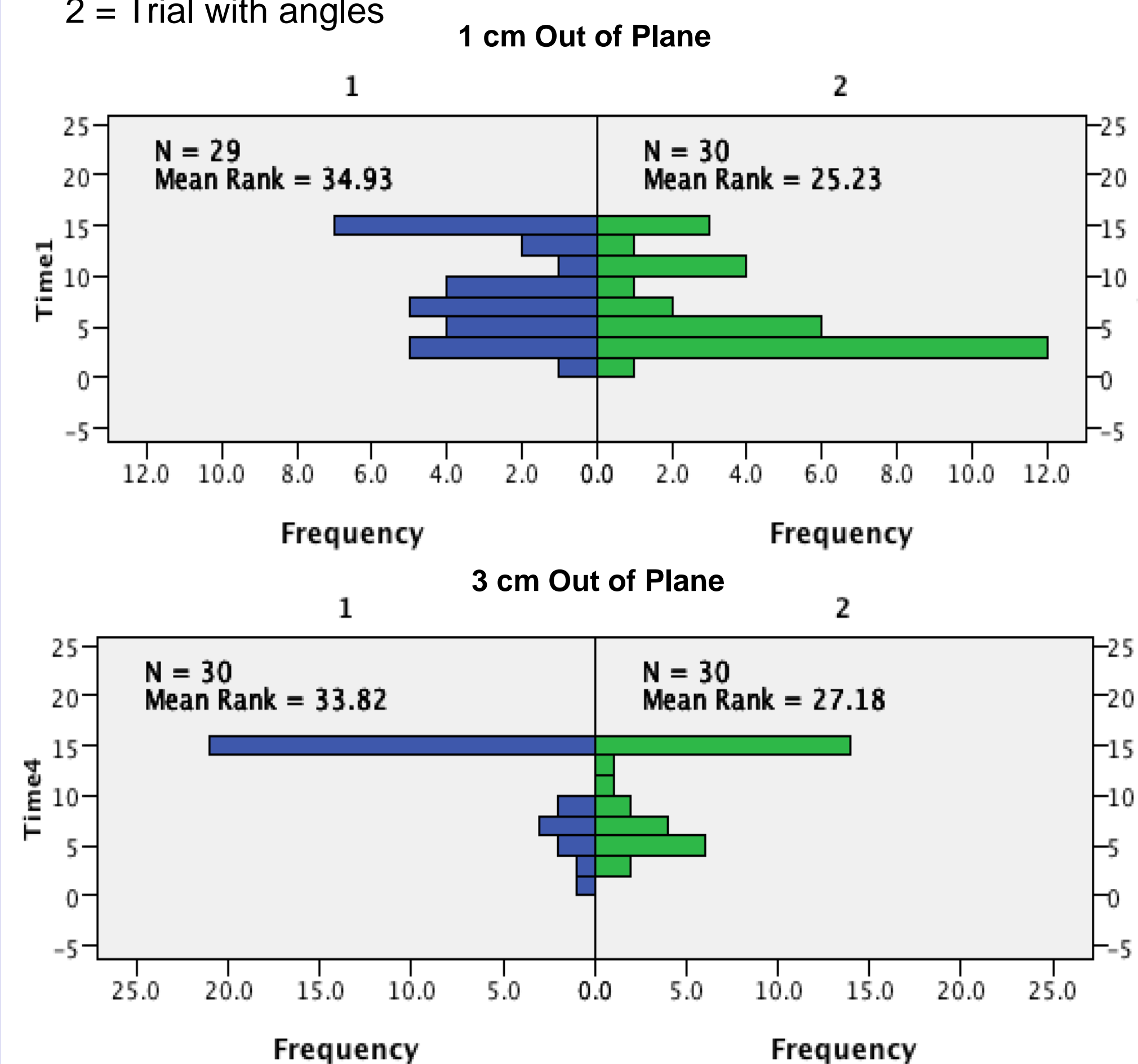


Table 2: Statistical Analysis of Data

Mann-Whitney U test comparing performance times

Depth/Approach	Mean Rank with no angles	Mean Rank with angles	Mann-Whitney U Value	Standardized Test Statistic	p-value
1 cm out of plane	34.93	25.23	292.000	-2.186	0.029
1 cm in plane	30.82	30.18	440.500	-0.149	0.881
3 cm out of plane	33.82	27.18	350.500	-1.1613	0.107
3 cm in plane	34.92	24.91	287.500	-2.256	0.021

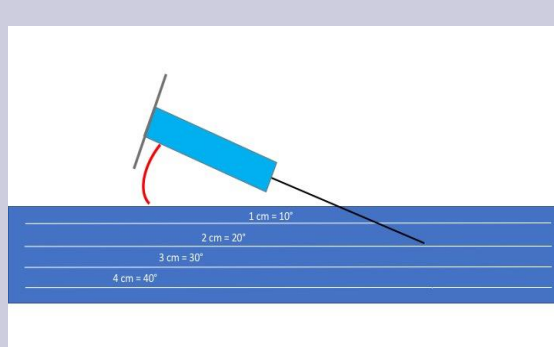
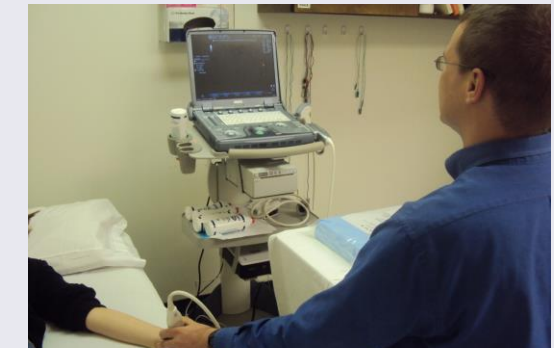

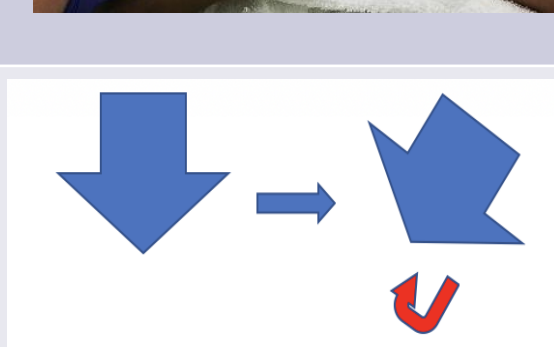
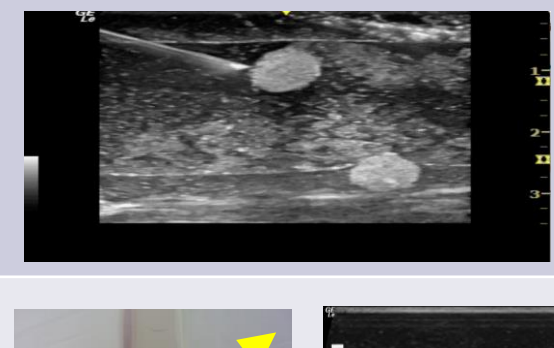
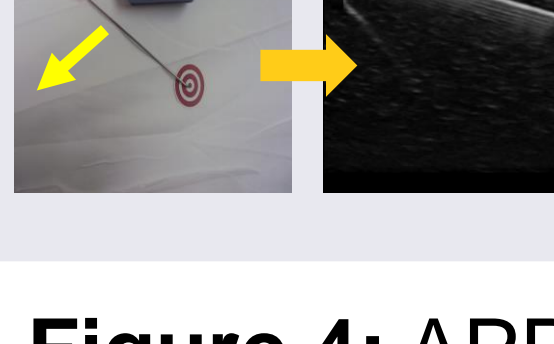
Mnemonic	Image	Description
<u>A</u> pproach		Choose the optimal angle of entry and distance from the transducer based on patient anatomy and depth of target.
<u>P</u> osition		Position of the patient and operator for optimal alignment. Transducer cover and prep is done at this point.
<u>P</u> erpendicular		Make sure probe is perpendicular to the skin so that the sound beam hits the needle directly.
<u>L</u> ift		Lift up one edge of the transducer to verify orientation.
<u>E</u> ntry		Needle entry is performed.
<u>S</u> weep		If needle not visualized after entry, sweep the probe while keeping the needle in the same position.

Figure 4: APPLES Mnemonic

DISCUSSION

- Performance times for the 1 cm out of plane approach for participants who did not receive the predefined angles (mean rank = 34.93) were statistically significantly higher than the performance times of the participants who did receive predefined angles (mean rank = 25.23), $U = 292.000$, $z = -2.186$, $p = 0.029$.
- Performance times for the 3 cm in plane approach for participants who did not receive the predefined angles (mean rank = 34.92) were statistically significantly higher than the performance times of the participants who did receive predefined angles (mean rank = 24.91), $U = 287.500$, $z = -2.256$, $p = 0.021$.
- 59 participants attempted the 3 cm in plane approach. Of the 30 participants who did not receive the predefined angles, 20 participants were able to hit the target. Of the 29 participants who received the angles, 27 participants were able to hit the target. There was a statistically significant association between receiving the predefined angles and hitting the target as assessed by Fisher's Exact test, $p = 0.021$.
- 95% of participants found the APPLES mnemonic helpful for learning and performing ultrasound guided procedures.
- 96.67% of participants indicated that being given the predetermined angles/distances would be helpful in learning and performing ultrasound guided procedures.

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