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Along or across the visual axis? Comparison of probe and needle alignment during in-plane ultrasound guided loco-regional techniques in skilled and non-skilled clinicians

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Abstract

Objective To evaluate two probe and needle handling methods, along or across the visual axis, in a group of novices and in a group of skilled clinicians.

Study design Prospective randomized crossover study.

Method Twenty-six students with no ultrasound and loco-regional anaesthesia experience (non-skilled group) and 6 clinicians familiar with ultrasound loco-regional anaesthesia (skilled group) were enrolled. The non-skilled group was asked to perform 2 tasks: the first on a phantom jelly model and the second on dog cadavers, whilst the skilled group performed only the second task. The tasks consisted in reaching a target point (simulated nerve on the jelly phantom and sciatic nerve on the cadavers) with the tip of the needle with an ultrasound-guided in-plane technique, using 2 different methods: across and along the visual axis. Each target was performed by all the operators three times for each probe handling methods. The time to reach the target and numbers of time the needle was not visible on the screen were recorded and used for the statistic analysis.

Results The along the visual axis method, in comparison to the across method, resulted in shorter time performance in both the skilled, (20.1 ± 8.9 vs 9.9 ± 5.4 seconds for the 2nd task), and the non-skilled group, (17.2 ± 15.7 vs 9.7 ± 8.1 seconds for the 1st task and 32.2 ± 26.1 vs 18.5 ± 11.6 seconds for the 2nd task).

Conclusion and clinical relevance In both groups, the along the visual axis method significantly reduced the time to complete the task. Results from this study support that along the visual axis method potentially increases the safety of the block and should be the preferential method of learning/teaching ultrasound guided regional anaesthesia.

1992 words (introduction-conclusion)

Introduction

Ultrasound guided regional anaesthesia (UGRA) improves block quality and lowers complication rate (Portela et al. 2018), however, besides the cost of equipment, the learning process to successfully and easily practice the blocks still remains a prominent drawback. When approaching UGRA, clinicians should be aware that learning curve could be slow and somehow frustrating and that commitment and determination are required to achieve satisfactory results. A study, conducted during a resident program, pointed out that major errors done by novices were: needle not visualized while advancing and unintentional probe movements (Sites et al. 2007). Practical simulations are a fundamental part of the training to speed up the learning process (Kim et al. 2014) even if, there is no standardisation about the number of simulations to be performed before satisfactorily execute a block (Narouze et al 2012; da Silva et al. 2017).

Another crucial point, for the learning curve process when performing UGRA, is the eye, probe and needle coordination. The advantage of the in-plane technique, compared to the out-plane, is that the first allows tracking the entire needle (shaft and tip) in real time during its advancement through the tissues. When the in-plane technique is used, the alignment between the probe and the needle is essential, in order to visualise the needle during the entire procedure.

Two methods of handling the transducer, when performing an in-plane technique, are described: along or across the visual axis. With the first method the transducer and the needle are oriented along the visual axis (figure 1A), while with the second they are oriented across the visual axis of the operator (Figure 1B).

The along the visual axis method has been showed to speeded up the learning curve in novices (Speer et al. 2013; Wilson et al. 2014; Lam, et al. 2016). To the authors' knowledge there is no information about the possibility that the along the visual axis method could improve the block performance in skilled clinicians. The aim of the present study is to evaluate the two probe handling methods, along or across the visual axis, in a group of novices veterinary students and in a group of skilled veterinary clinicians. Our hypothesis is that along method would reduce time to task completion, and increases the proportion of time in which the needle is visualised when compared to the across method, for both novices and skilled clinicians.

Materials and methods

After signed a consent form to participate to the present study, twenty-six students (non-skilled group) of the 5th year of the Veterinary College of University of *** and 6 veterinary clinicians (skilled group) were voluntarily enrolled. The students were considered as novice, if they did not have any previous ultrasound and regional anaesthesia techniques experience. The skilled group was composed of veterinary clinicians that had already performed at least 40 UGRA procedures in the clinical setting (Kim & Tsui, 2019).

Task

At the beginning of the study, two tasks were explained and showed by a senior clinician expert in ultrasound guided regional techniques (more than 8 years experience). The first was explained only to the novice group while the second task to both groups.

First task consisted in reaching with the tip of the needle a simulated nerve positioned at 2 cm of depth, in a specific jelly phantom (Pediatric 4 Vessel Ultrasound Training Block Model, CAE) in a short axis vision and in-plane technique.

The second task was performed on 6 thawed dog cadavers (mixed breed dogs 19-27 kg, whose cadaver the owners consented the use for research purposes) and consisted in reaching with the tip of the needle the sciatic nerve (in short axis vision), using an in-plane technique as described by Echeverry et al. 2010.

Procedures

The tasks were performed by participants using, a 22 gauges, 30-degree bevel, 85 mm ultrasound visible nerve block needle, (Visioplex; Vygon **), and a linear array (HFL50, 15-6 MHz) of a dedicated ultrasound machine (Sonosite SII) with the monitor positioned in front of the operator.

The veterinary clinicians in the skilled group were familiar only with the across method.

For each group, the participants performed the tasks, on phantom and cadavers (non-skilled group) or only on cadavers (skilled group), 3 times for each method. For each participant the sequence of execution was randomly generated by a specific software (www.random.org).

The study was completed on the same day and on the same cadavers: the skilled group started in the morning followed by the non-skilled group; the latter was not present to the performance of the skilled group. During the execution, no injection was performed in order not to alter the tasks.

The time between the first needle-tissue contact (phantom or cadaver) and the target achievement (the tip of the needle touching the simulate nerve or sciatic nerve) was recorded as the time to achieve the target. For each method, the mean of the three performances was calculated and used for the statistics.

The same veterinary clinician, with proved expertise in UGRA, evaluated all performances and verified the correct execution of the tasks; in case the needle was not visible on the ultrasound screen, the expert advised the operator to stop and correct the position in order to show the entire needle on the screen. The number of times the needle was not visible on the screen was registered for each performance and the median of the three used for the statistical analysis.

Statistical analysis

Normal distribution was evaluated with D'Agostino & Pearson test. Parametrical data are expressed as mean and standard deviation, while non-parametrical data (number of times that needle was not visible on the screen) by median and range. The comparison of the time to complete the target between across and along method within each group (skilled and non-skilled) was performed with a paired Student T test, while the comparison between the 2 groups (skilled vs non-skilled) by an unpaired Student T test. Wilcoxon and Mann-Whitney tests were used to compare the number of times that needle was not visible on the screen between the 2 methods within each group and between the 2 groups, respectively. Statistical significance was set at $p < 0.05$. Prism Version 6.0 (GraphPad Software Inc., CA, USA), was used to analysed data.

Results

All participants completed the tasks. Times to complete the tasks were significantly shorter for the along the visual axis method, for both groups (table 1).

Between the 2 groups, the time to complete the task and the amount of time the needle was not visible resulted significantly shorter p=0.003 and lower p=0.02, in the skilled group compare to the non-skilled for the along method. No statistical differences between the 2 groups were found for the across method.

Discussion

The results of this study are consistent with the literature (Speer et al.2013; Lam et al. 2016) confirming that, the needle advancing along the visual axis improves the needle imaging (reduced period of the time without needle visualisation) shortening the time to complete the target in novices.

Moreover, the present study demonstrated that, the along the visual axis might also be beneficial for the skilled veterinary clinicians improving their performance (lesser time to achieve the target in comparison to the across visual axis).

The amount of time the needle was not visible during the procedure was shorter during the along method, supporting the theory that for the operator it is easier to maintain the alignment between the probe and the needle, when the handling is on the same line of the visual axis and the ultrasound monitor (Wilson et al.2014).

A reduction of time in which the needle is not visible may increase the safety of the procedure, reducing the risk of accidental vascular or neural damage or the block failure.

The results obtained from this study suggest that handling the probe along the visual axis is beneficial not only for novices but also for skilled clinicians, in which the steep portion of the learning curve could be considered completed.

In the skilled group, the number of times in which the needle was not visible did not differ between the across and the along visual axis method. This could be related to the small number of clinician enrolled or to the experience of the skilled clinician in needling and making fine movements of the probe. It would be interesting to evaluate if the time to perform the technique could be reduced even in more challenging blocks (i.e. brachial plexus block).

It is important to highlight that veterinary clinicians enrolled in the study were familiar only with the across method: nonetheless the execution time resulted halved for the along in comparison to the across method.

A study, conducted on medical students, showed that besides a reduced time to reach the target and a higher success rate, using the along visual axis method resulted in less mental and physical demand, less frustration and a significantly higher learner assessment of their own ability (Wilson et al. 2014). This is an important aspect of the learning curve, because the frustration, due to difficulties encountered in executing a block, could be responsible of anxiety and tension when performing a block, thus reducing the learning process improvements, whilst positive mood has been demonstrated to be beneficial in the learning process (Nadler et al.2010).

The present study has some limitations that need to be addressed: the first is the lack of power analysis and the dissimilarity of the number of the enrolled operators for the two groups. Due to the voluntary enrolment, it was not possible to settle the number of enrolees. However a post hoc calculation with an alpha error set at 0.05 showed a power of 79.4% and 68.3% for the skilled and non-skilled group, respectively; despite this the statistical analysis resulted in a significant difference between the 2 methods. Increasing the number of clinician and the power could maybe result in a significant difference in the needle visualisation for the skilled group with the along the visual axis method.

A possible source of bias could have arise during the second task execution, where the non-skilled group compare to the skilled one, had the possibility to train 6 times (3 times for 2 methods) during the first task. The aim of the study, however, was not to compare the 2 groups, but the 2 handling methods and to establish if the along the visual axis during an UGRA would be beneficial also in skilled operators.

During the execution of the second task, the use of different cadavers, could have represented a further source of bias: even though the target was the sciatic nerve of the same animal for all the executors, the different tissue conditions between animals could have affect the inter-operator execution of the task.

Moreover, only one 'real' target (sciatic nerve) was approached and the evaluation of more targets, with different level of difficulty, would be useful to have a more complete scenario.

Finally, to exclude inter-operator variability, all performances were evaluated by the same expert clinician, however, at the same time this is a potential limit because the evaluations were done on the same day by only one evaluator, leading to errors due to fatigue and distraction.

The alternative would have been to video record all procedures and post evaluate the performances by a group of experts but this option was not available at the time of the study. However, interaction with the operator was still necessary to correct the needle visualisation during the performance.

Conclusion

In conclusion, this study demonstrated the influence of the alignment of eyes, probe, and needle when performing the UGRA techniques. The handling of probe and needle along the visual axis, during an in-plane technique, resulted in a quicker learning curve for the novices and improved the performances of the skilled operators. The increased proportion of the time that needle was viewable on the screen, may potentially increases the safety and outcome of the block resulting in the preferential method of learning/teaching the ultrasound guided regional anaesthesia.

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Table 1 Means and standard deviations of the time (seconds) to achieve the target and median and range of times the needle was not visible, in the skilled and non-skilled group for each task (1st: blue phantom; 2nd: sciatic nerve) and for each method (probe-needle handling across and along the visual axis). *significantly different from the across visual axis.

		1st task	**2nd task**	
		Non-skilled	**Skilled**	**Non-skilled**
Task time (seconds)	**Across**	17.2 ± 15.7	20.1 ± 8.9	32.2 ± 26.1
	Along	9.7 ± 8.1*	9.9 ± 5.4*	18.5 ± 11.6*
	p value	0.03	<0.001	0.002
Times needle not visualized	**Across**	2 (1-5)	0 (1-3)	2 (0-5)
	Along	1 (0-4) *	0 (0-3)	1 (0-4) *
	p value	<0.001	0.23	<0.001

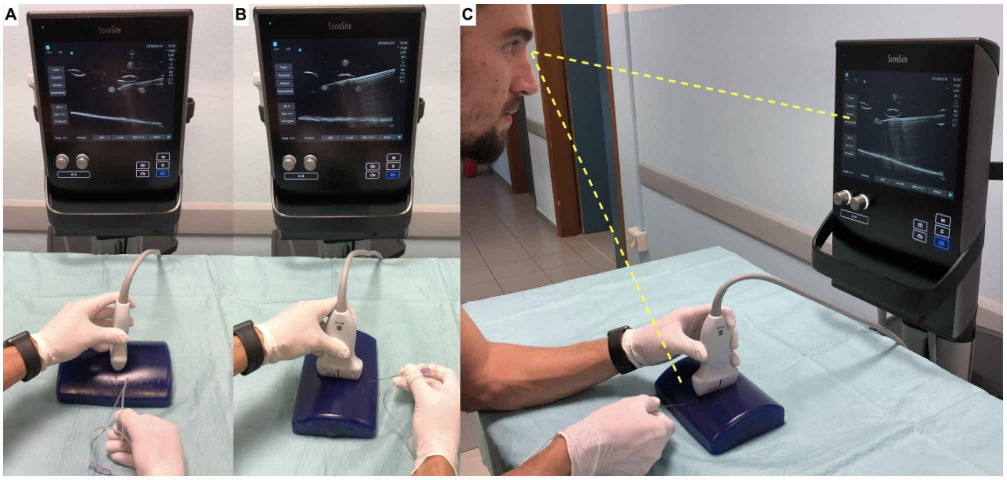

Figure 1. Probe and needle position along the visual axis (A) or across the visual axis (B). Eye, probe, needle and monitor alignment (C).

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