Title Page

Title: Identifying variant anatomy during ultrasound-guided regional anaesthesia - do we do it, or do we see what we want to see?

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Identifying variant anatomy during ultrasound-guided regional anaesthesia - do we do it, or do we see what we want to see?

Structural and functional variation of the peripheral nervous system is known to exist. Recent clinical anaesthesia publications have discussed the potential for such variation to impact the efficacy of regional anaesthesia techniques (1,2). Our group has been assessing anatomy of the superficial peroneal nerve (SPN, aka superficial fibular nerve) (3), as we find the dorsum of the foot may develop incomplete anaesthesia during awake surgery under ankle block. During this work we have determined that the natural variation in structure of the SPN is described in the anatomical literature (4-8). However, clinical literature pertaining to the SPN and ankle block often focus on the clinical aspects and the anatomical descriptions may omit some of this detail (9). This led the authors to question whether a failure to transfer knowledge from anatomical science to clinical practice may lead to variability in identifying relevant anatomy by anaesthetists, which in turn may influence regional anaesthesia success. We therefore assessed the recognition of variant anatomy of the SPN by two consultant anaesthetists. Both have completed advanced training in ultrasound-guided regional anaesthesia (through the Tayside Regional Anaesthesia Fellowship) and are considered local experts, with publications in this field.

With approval from the University of St Andrews School of Medicine Ethics Committee (MD13364), we recruited 16 volunteers with written informed consent, which allowed us to assess the sonoanatomy of the SPN on 32 limbs. There was an equal male to female ratio, with a mean age of 29 years (min-max range 19 - 50). On the subjects' lower limbs, we marked the most prominent part of the lateral malleolus (LM) and the head of the fibula (HF), and then drew a straight line on the skin between these two points (LM-HF line).

The ultrasound operators were not informed of the objective of recognising variant anatomy. We asked them to independently identify the nerves on ultrasound at the anterolateral ankle, then trace them proximally to the point at which they penetrated the deep (crural) fascia and further to the point of origin at the neck of the fibula. In our practice, the site at which we target the SPN during an ultrasound-guided ankle block is the point immediately after it has penetrated the fascia to lie in a more superficial plane. This point was marked and then a second straight line (intersecting line) was drawn from it to intersect the LM-HF line (figure 1). The distance from the LM to the point at which the intersecting line crossed the LM-HF line was measured, as was the total distance of the LM-HF line. A ratio of these distances was calculated using existing methodology (3) - a figure we have used as a guide to begin ultrasound assessment of the leg to identify the SPN in clinical practice. The two ultrasound operators were then informed of the results of previous work (3-8), which demonstrated the presence of variation in the course and structure of the SPN. They were then asked to re-scan the legs of the same volunteers scanned earlier, to specifically assess for the presence of more than one branch of the SPN emerging through the deep fascia of the leg.

The SPN was identified in all limbs with the mean ratio of distances (LM-intersecting line : LM-HF distances) being 0.44 (SD 0.1, 95% CI=0.40-0.48). On the first scan, the SPN was identified as emerging through the deep fascia at a single point in all cases. On the second scan, when variant anatomy was specifically assessed, accessory branches of the SPN were found piercing the deep fascia in a different location to the main branch in five of the 32 legs (15.6%).

These data support existing evidence that one can identify structural anatomical variation of peripheral nerves on ultrasound (in this case multiple points of emergence of the SPN)

(7). Such variation may already be described in anatomical literature, to differing extents for different body regions and structures. However, the data presented is consistent our hypothesis that this knowledge may not transfer to anaesthesia literature and therefore is not accounted for in clinical practice. In the case of regional anaesthesia, this can mean we fail to account for variant structure(s) when performing peripheral nerve blocks and so may not target all the nerve or branches. Furthermore, even the correct nerve or branches may not be targeted - small superficial nerves are sometimes difficult to identify on ultrasound and the results of this short study could also be interpreted as initial wrong identification of the nerve structures. These factors may in turn adversely influence the efficacy of regional anaesthetic techniques. Of course, although structural variation was noted in this study, the authors recognise that this particular example may not necessarily result in a clinically significant difference in outcome during blockade of the SPN. Nonetheless, these data suggest that clinical anaesthetists should be cognisant of such information when performing ultrasound guided regional anaesthesia. The authors do note the difference in ratio between the first (3) and second studies: 0.31 (SD±0.07) and 0.44 (SD±0.1) respectively. This could reflect a true difference in the two populations studied. However, some of the volunteers scanned were the same as in our previous study cohort, so may reflect the fact that different anaesthetists scanned volunteers in the two studies and that sonoanatomy interpretation is subjective. This in itself may contribute to perceived variation and ultimately regional anaesthesia failure.

As clinicians, we feel more should be done to consolidate our anatomical knowledge, establish more robust systems of ultrasound assessment and sonoanatomy interpretation, and ensure this information is transferred to clinical practice. Where the literature on anatomical variation does not exist, we would encourage anaesthetists to stimulate investigation of this rather than accept incomplete accounts of the anatomy.

Author contributions

JB: study concept and design, acquisition of data, data interpretation, drafting of manuscript, critical revision of manuscript, approval of article

KT: recruitment of volunteers, data analysis/interpretation, critical revision of manuscript, approval of article

AT: study design, acquisition of data, critical revision of manuscript, approval of article

JH: study design, acquisition of data, critical revision of manuscript, approval of article

PR: acquisition of data, critical revision of manuscript, approval of article

AM: acquisition of data, critical revision of manuscript, approval of article

FC: drafting of manuscript, figure preparation, critical revision of manuscript, approval of article

OV: study design, data analysis/interpretation, drafting of manuscript, critical revision of manuscript, approval of article

CG: study concept and design, acquisition of data, critical revision of manuscript, approval of article

The study concept and design was a result of discussions between JB, AT, JH, OV and CG. Volunteer recruitment was performed by KT and data acquisition by JB, KT, AT, JH, PR, AM and CG (PR and AM gathered the ultrasound data, but the volunteers were prepared and the demographic data gathered by JB, KT, AT and JH). Data analysis was performed by KT and OV, with figure preparation by FC. JB drafted the manuscript and all authors have had the opportunity to contribute to critical revision of the manuscript and approval of the article.

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Conflict of Interest

None declared.

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