14. Hillen B, Simon P, Grimminger PP, Gockel I, Pfirrmann D. Use of a perioperative web-based exercise program for a patient with Barrett's carcinoma scheduled for esophagectomy. *Case Rep Oncol* 2019; **12**: 755–64
15. Olivero CF, Collado LM, Sarceda JJ, et al. The use of a smartphone application improves postoperative outcomes in patients undergoing lung cancer resection. *J Thorac Oncol* 2019; **14**: S882
16. Waterland JL, Ismail H, Amin B, Granger CL, Denehy L, Riedel B. Patient acceptance of prehabilitation for major surgery: an exploratory survey. *Support Care Cancer* 2020 May 28. https://doi.org/10.1007/s00520-020-05547-1

British Journal of Anaesthesia, 125 (5): 649–651 (2020)
doi: 10.1016/j.bja.2020.08.013
Advance Access Publication Date: 28 September 2020

Fascial plane blocks in regional anaesthesia: how problematic is simplification?

Peter Marhofer[1,*], Georg C. Feigl[2] and Phil M. Hopkins[3]

[1]Department of Anaesthesiology and General Intensive Care Medicine, Medical University of Vienna, Vienna, Austria, [2]Department of Macroscopic and Clinical Anatomy, Gottfried Schatz Research Centre, Medical University of Graz, Graz, Austria and [3]Institute of Medical Research at St James's, University of Leeds, Leeds, UK

*Corresponding author. E-mail: peter.marhofer@meduniwien.ac.at

This editorial accompanies: Comparing erector spinae plane block with serratus anterior plane block for minimally invasive thoracic surgery: a randomised clinical trial by Finnerty et al., *Br J Anaesth* 2020:125: 802–810, doi: 10.1016/j.bja.2020.06.020

Keywords: anatomy; facial plane block; local anaesthesia; nerve block; regional anaesthesia

Introduction of ultrasound guidance into the clinical practice of regional anaesthesia was revolutionary and brought the potential for superior efficacy and safety compared with pre-ultrasound practice.[1] Fulfilling this potential demands acquisition of new knowledge (sonographic anatomy and physical principles of ultrasound) and technical skills.[2] The transition of non-neuraxial regional anaesthesia from a 'hit or miss' approach to a precision image-guided approach has led to an increasingly important role in perioperative medicine. The strength of ultrasound-guided techniques in experienced hands is that local anaesthetics can be administered as close as possible to nerve structures while damage to the nerve and adjacent anatomical structures can be avoided.[3] The fact that so many anaesthesiologists around the world have undertaken the necessary learning and training to expand their clinical repertoire to encompass ultrasound-guided regional anaesthesia represents a real triumph for our specialty.

The earliest applications of ultrasound-guided regional anaesthesia were for plexus and peripheral nerve blocks of the limbs.[4,5] The availability of point-of-care ultrasound machines and sonographic skills soon led to an expanding number of approaches to providing regional anaesthesia of the trunk using fascial plane blocks. The underlying aims of these techniques were to provide peripheral regional anaesthesia of the trunk, thereby replicating the advantages seen with widespread adoption of ultrasound-guided regional anaesthesia of the limbs, while avoiding the side-effects and complications of neuraxial anaesthesia. Their uptake was fuelled in part by the enthusiasm of anaesthesiologists to broaden use of their newly acquired sonographic skills. The partial list of fascial plane blocks includes transversus abdominis plane,[6] pectoral I and II,[7] serratus anterior plane,[8,9] erector spinae plane,[10] rectus sheath,[11] quadratus lumborum,[12] and transversalis fascia blocks.[13] The fundamental problem, however, is that the notion that truncal blocks can achieve the same reliable efficacy as ultrasound-guided regional anaesthesia of the limbs neglects the essence of the latter's success: the precise administration of local anaesthetics as close as possible to the relevant nerve structures. Although some blocks of the trunk do involve nerves coming into direct contact with the local anaesthetic (e.g. rectus sheath block), most do not have a clear anatomical rationale to predict success and efficacy even if local anaesthetic is deposited at the intended landmark.

The current issue of *British Journal of Anaesthesia* includes a comparative study of the perioperative impact of erector spinae *vs* serratus anterior plane blocks for minimally invasive thoracic surgery.[14] Finnerty and colleagues[14] treated 60 patients undergoing thoracoscopic surgery with one of the two regional techniques and compared the quality of recovery and overall morbidity. Their results suggest that the erector spinae plane block was superior in all outcomes. In evaluating this study, it is first necessary to appreciate that pain after so-called 'minimally invasive surgery' is a clinical problem worthy of investigation. Contrary to widespread belief, the

DOI of original article: 10.1016/j.bja.2020.06.020.

term 'minimally invasive' is based only on the size of skin incision(s), and has nothing to do with the degree of tissue trauma ('under the skin incision'), haemodynamic effects, and inflammatory reactions. Therefore, it is absolutely necessary to seek to optimise evidence to improve postoperative analgesia for minimally invasive surgical procedures through sound clinical trials.

There are indeed previous reports that have addressed this subject.[15] Meta-analyses of trials investigating the efficacy of erector spinae[16,17] and serratus anterior blocks[18,19] compared with systemic analgesia alone are largely inconclusive because the evidence is weak from small, low-quality heterogenous studies. At best, it appears that erector spinae and serratus anterior blocks provide statistically significant but clinically unimportant changes compared with systemic analgesia alone.[16–19] We argue that new techniques should be compared with the current gold standard, which in the case of analgesia for thoracic surgery is thoracic epidural or paravertebral analgesia. It is unfortunate that Finnerty and colleagues[14] also did not compare one or both fascial plane techniques to these gold standards, and we disagree with their rationale for not doing so. Potential complications of thoracic epidural and paravertebral blocks from needle damage of related structures can be limited by attentive practice of skilled practitioners, and we should be seeking to improve their safety further using ultrasound-assisted and ultimately ultrasound-guided techniques.[20,21] Effects on the autonomic nervous system are predictable and can be effectively preempted and managed. The anatomical rationale for these more central regional anaesthetic techniques is clear, with the local anaesthetic injected directly adjacent to the relevant neuronal structures, This is in contrast to the anatomical basis of the two regional anaesthetic techniques investigated by Finnerty and colleagues,[14] which is worth considering in further detail.

The *erector spinae* are the intermediate group of intrinsic back muscles formed by the iliocostalis, longissimus, and spinalis muscles on either side of the spine from the sacral region to the base of the skull. The muscle group is covered by the thoracolumbar fascia, which is a complicated anatomical structure because it consists variably of two or sometimes three layers (anterior or deep, middle, posterior or superficial). The anterior and middle layers insert onto the ribs in the thoracic region[22] with extensions to the transverse processes. The deep and middle layers insert at the costal processes in the lumbar region, where this layer is called the lumbar aponeurosis or quadratus lumborum fascia. The posterior layer inserts onto the tips of the spinous processes. The erector spinae plane block involves local anaesthetic injection below the muscle group and adjacent to the tip of the transverse processes. The mechanism of an erector spinae plane block assumes that local anaesthetic diffuses through the superior costotransversal ligament or medial to it passing through the costotransverse foramina in the paravertebral space with subsequent block of spinal nerves (ventral and dorsal rami) and additional epidural spread through the intervertebral foramina medially. The entire system resembles chain mail, built by oblique and longitudinally oriented muscles in a three-dimensional network, creating small loose connective gaps, where resolution by ultrasound can be problematic.

The *serratus anterior* plane block involves local anaesthetic injection anterior or superficial (superficial serratus anterior plane block) and deep to the serratus anterior muscle (deep serratus anterior plane block) at the lateral chest wall (midaxillary line).[23] The superficial block reaches the lateral branches of the intercostal nerves piercing the serratus anterior muscle. The long thoracic nerve passes close to the fascia covering the serratus anterior muscle, and might be affected as well. The deep serratus plane block reaches the space between the thoracic wall and the serratus anterior muscle. This compartment contains smooth connective tissue forming the thoracoscapular gliding gap and explains medial spread to the insertion of the thoracolumbar fascia on the ribs. The lateral branches of the intercostal nerves will be blocked as they pierce the intercostal muscles.[24] Medial spread may also reach the lateral branches of the dorsal branches of the spinal nerves. Large volumes of local anaesthetic solutions diffuse inconsistently in the intercostal spaces with consecutive blockade of intercostal nerves.

These considerations and descriptions illustrate the uncertainty and potential variability of the regional techniques investigated by Finnerty and colleagues.[14] Although we congratulate them for exploring outcomes of these blocks, proponents of these blocks often highlight the relative simplicity of the technique without appropriate identification of the mechanisms of nerve block. More recent studies have sought to test erector spinae[25] or serratus anterior[26] blocks for non-inferiority compared with thoracic paravertebral block, but these studies are not designed to exclude inferiority,[27] whereas the study by Hanley and colleagues[26] also lacked equipoise between the interventions.

Nevertheless, the results of Finnerty and colleagues[14] suggest a greater analgesic effect of the erector spinae block compared with the serratus anterior plane block after thoracoscopic surgery. An understanding of the anatomical basis for these blocks might help to understand if this is likely to be a reproducible and generalisable finding. In the meantime, we should not forget the simple paradigm of regional anaesthesia: 'put the right dose of the right drug in the right place'.[28] Where possible we should not return to a hit-or-miss approach to regional anaesthesia. Our patients expect excellent perioperative pain therapy with minimal side-effects, which is one of the most important parts of our job.

Funding

Departmental sources.

Declarations of interest

PMH is a board member of the *British Journal of Anaesthesia*.

References

1. Marhofer P, Greher M, Kapral S. Ultrasound guidance in regional anaesthesia. *Br J Anaesth* 2005; **94**: 7–17
2. Chin KJ, Chan V. Ultrasound-guided peripheral nerve blockade. *Curr Opin Anaesthesiol* 2008; **21**: 624–31
3. Marhofer P, Harrop-Griffiths W, Kettner SC, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: part 1. *Br J Anaesth* 2010; **104**: 538–46
4. Kapral S, Krafft P, Eibenberger K, Fitzgerald R, Gosch M, Weinstabl C. Ultrasound-guided supraclavicular approach for regional anesthesia of the brachial plexus. *Anesth Analg* 1994; **78**: 507–13
5. Marhofer P, Schrögendorfer K, Koinig H, Kapral S, Weinstabl C, Mayer N. Ultrasonographic guidance

improves sensory block and onset time of three-in-one blocks. *Anesth Analg* 1997; **85**: 854–7
6. Bonnet F, Berger J, Aveline C. Transversus abdominis plane block: what is its role in postoperative analgesia. *Br J Anaesth* 2009; **103**: 468–70
7. Blanco R, Fajardo M, Parras Maldonado T. Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. *Rev Esp Anestesiol Reanim* 2012; **59**: 470–5
8. Park MH, Kim JA, Ahn HJ, Yang MK, Son HJ, Seong BG. A randomised trial of serratus anterior plane block for analgesia after thoracoscopic surgery. *Anaesthesia* 2018; **73**: 1260–4
9. Southgate SJ, Herbst MK. *Ultrasound guided serratus anterior blocks*. Treasure Island, FL: StatPearls Publishing; 2020
10. Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. *Reg Anesth Pain Med* 2016; **41**: 621–7
11. Willschke H, Bösenberg A, Marhofer P, et al. Ultrasonography-guided rectus sheath block in paediatric anaesthesia—a new approach to an old technique. *Br J Anaesth* 2006; **97**: 244–9
12. Kadam VR. Ultrasound-guided quadratus lumborum block as a postoperative analgesic technique for laparotomy. *J Anaesthesiol Clin Pharmacol* 2013; **29**: 550–2
13. Ahiskalioglu A, Aydin ME, Doymus O, Yayik AM, Celik EC. Ultrasound guided transversalis fascia plane block for lower abdominal surgery: first pediatric report. *J Clin Anesth* 2019; **55**: 130–1
14. Finnerty D, Griffin M, McMahon A, McNamara J, Hartigan S, Buggy D. Erector spinae plane block versus serratus anterior plane block for quality of recovery and morbidity after minimally invasive thoracic surgery: a prospective, randomised, double-blind clinical trial. *Br J Anaesth* 2020 [update]
15. Smith LM, Barrington MJ, St Vincent's Hospital M. Ultrasound-guided blocks for cardiovascular surgery: which block for which patient. *Curr Opin Anaesthesiol* 2020; **33**: 64–70
16. Huang J, Liu JC. Ultrasound-guided erector spinae plane block for postoperative analgesia: a meta-analysis of randomized controlled trials. *BMC Anesthesiol* 2020; **20**: 83
17. Kendall MC, Alves L, Traill LL, De Oliveira GS. The effect of ultrasound-guided erector spinae plane block on postsurgical pain: a meta-analysis of randomized controlled trials. *BMC Anesthesiol* 2020; **20**: 99
18. Zhang X, Zhang C, Zhou X, et al. Analgesic Effectiveness of perioperative ultrasound-guided serratus anterior plane block combined with general anesthesia in patients undergoing video-assisted thoracoscopic surgery: a systematic review and meta-analysis [published online ahead of print, 2020 Jun 3] *Pain Med* 2020. https://doi.org/10.1093/pm/pnaa125. pnaa125
19. Liu X, Song T, Xu HY, Chen X, Yin P, Zhang J. The serratus anterior plane block for analgesia after thoracic surgery: a meta-analysis of randomized controlled trails. *Medicine (Baltimore)* 2020; **99**, e20286
20. Marhofer D, Marhofer P, Kettner SC, et al. Magnetic resonance imaging analysis of the spread of local anesthetic solution after ultrasound-guided lateral thoracic paravertebral blockade: a volunteer study. *Anesthesiology* 2013; **118**: 1106–12
21. Marhofer P, Kettner SC, Hajbok L, Dubsky P, Fleischmann E. Lateral ultrasound-guided paravertebral blockade: an anatomical-based description of a new technique. *Br J Anaesth* 2010; **105**: 526–32
22. Hafferl A, Rücken. *Lehrbuch der Topographischen Anatomie des Menschen*. Berlinspl: Springer; 1957. p. 653–61
23. Piracha MM, Thorp SL, Puttanniah V, Gulati A. "A tale of two planes": deep versus superficial serratus plane block for postmastectomy pain syndrome. *Reg Anesth Pain Med* 2017; **42**: 259–62
24. Mayes J, Davison E, Panahi P, et al. An anatomical evaluation of the serratus anterior plane block. *Anaesthesia* 2016; **71**: 1064–9
25. Taketa Y, Irisawa Y, Fujitani T. Comparison of ultrasound-guided erector spinae plane block and thoracic paravertebral block for postoperative analgesia after video-assisted thoracic surgery: a randomized controlled non-inferiority clinical trial. *Reg Anesth Pain Med* 2019; **45**. https://doi.org/10.1136/rapm-2019-100827. rapm-2019-100827
26. Hanley C, Wall T, Bukowska I, et al. Ultrasound-guided continuous deep serratus anterior plane block versus continuous thoracic paravertebral block for perioperative analgesia in videoscopic-assisted thoracic surgery. *Eur J Pain* 2020; **24**: 828–38
27. Leung JT, Barnes SL, Lo ST, Leung DY. Non-inferiority trials in cardiology: what clinicians need to know. *Heart* 2020; **106**: 99–104
28. Rajendram R, Pemberton P, Hayward A. Regional anaesthesia always works—provided you put the right dose of the right drug in the right place. *Br J Anaesth* 2011; **107**: 103–4