



Rural to Remote to the Recent Trends in Regional Anaesthesia

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Regional anaesthesia (RA) has undergone significant transformation over the last few decades from being a dispensable part of anaesthesia to presently being the core skill and foundational pillar of anaesthesia in contemporary anaesthesia practice. RA has always been a flexible field—focused on pragmatism, using minimal resources efficiently, tailoring anaesthesia to individual perioperative needs, and prioritising patient-centred outcomes [1]. This practical based approach of maximizing resource utilisation has been most evident in rural and remote areas, where clinicians have since long turned limited resources into innovative solutions. Today, the same values that helped RA thrive in such settings are fueling its newest exciting developments: portable technology, built-in safety, interdisciplinary collaboration, scientific breakthroughs, and advent of artificial intelligence, all contributing to reconfiguration of RA to be a more refined, evidence-based, and widely adopted approach in contemporary medical practice [1, 2]. From its roots in resource limited rural practice to its cutting-edge modern advances, RA continues to make progress in tandem with our dynamic speciality.

RA has been a key skill in the armamentarium of anaesthesiologists working in rural and remote areas since ages to solve the limited infrastructures and to navigate the complex clinical scenarios that were far fetched with general anaesthesia (GA). It has been more of a necessity than a luxury in these set ups which have furthered innovations in this field. Conditions in many of these set ups is far from the recommended guidelines for basic minimum standards to provide anaesthesia

with an overall limited access to clean and well equipped operation rooms with central pipelines, anaesthesia workstations, advanced monitoring techniques, ventilators with advance modes, anaesthesia and emergency drugs, fluid and blood products, and post-operative high-dependency or intensive care unit [3, 4]. The only monitor might be the vigilant eye of an experienced anaesthesiologist. The emphasis has always been on minimally resource intensive opioid sparing anaesthesia techniques requiring lesser consumables and drugs, preserving spontaneous ventilation, allowing faster recovery and hospital discharge, and minimising opioid related adverse events [4]. These objectives can readily be met by incorporating RA into anaesthesia Use of RA to provide procedural anaesthesia avoids the need to handle the airway in these resource limited facilities while ensuring patient safety as the complications have remained astonishingly low [5]. Similarly, RA has revolutionised trauma care in remote areas—be it on-arrival blocks, facilitating closed reductions, physiotherapy; providing rib fracture analgesia with safer fascial plane blocks.

While resource constraint and economical use of resources has been the main driving factor in RA adoption in these rural and remote set-ups, safety remains the topmost priority. The widespread use of nerve stimulators and now even ultrasound is a testament to that. Anaesthesiologists working in these areas have realised the importance of safety and precision especially since rescue options are limited. Ultrasound has enhanced the safety of RA multi-folds by

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visualising needle trajectory and avoiding critical structures, reducing the dose of local anaesthetist and improving the block success [6]. Innovations like portable and pocket-sized ultrasound compatible with smartphones have made the integration of ultrasound even more feasible for freelancers who carry their own equipment. However, cost concerns and stringent laws by the government have made procurement and use of ultrasound difficult for free lancers in India and they may still have to rely on landmark or neurostimulation guided blocks.

Furthermore, even with the use of ultrasound intraneural injection cannot be ruled out. Hence, use of multimodal techniques comprising ultrasound, injection pressure monitoring, echogenic needles, use of AI and neurostimulation has been advocated as identified by Arora D in a review article on intrafascicular injection in this issue [7]. However, these would not be available in majority remote and rural areas. A breakthrough in the RA practice is the introduction and widespread popularity of fascial plane blocks such as transversus abdominis plane (TAP) block, erector spinae plane block (ESPB), serratus anterior plane block (SAPB) etc., permitting excellent analgesia with remarkable safety profile, preserving hemodynamic stability and avoiding damage to critical structures facilitating easy recovery and discharge [8]. Hence, these techniques have further expanded our armamentarium and provided us with enumerable options to choose from to suit individual patient profiles.

Enhanced recovery after surgery (ERAS) pathways utilise the multimodal analgesia with RA as a central component [9]. The concept of multimodal analgesia was rooted in the rural and remote anaesthesia practice as a means to reduce risk due to opioid analgesics by incorporating various non-opioid analgesics and RA. Recent trends favour ambulatory-friendly modalities: single-shot blocks with long-acting local anaesthetics; low-volume techniques that spare motor function; and even portable disposable infusion pumps which allow continuous peripheral nerve block on ambulatory basis. Though considered contemporary developments, these practices providing safe analgesic management are a boon to anaesthesiologists working in rural and remote settings furthering the safety and efficacy.

Another major advancement which has changed the landscape of RA in rural and remote areas is easy access to training and mentorship. Tele-mentoring has bridged the gap in guidance and supervision available in remote areas [10]. Various educational forums on social media enable discussion and almost instant problem-solving. Furthermore, the expanding research base has provided newer insights on the nitty-gritty of RA.

Artificial intelligence (AI) is entering RA, but the most promising applications are humble: real-time probe orientation hints, automatic structure labelling, and needle-tip detection—tools that teach as they guide [11]. Augmented reality overlays may soon help a novice reproduce an expert's probe and needle alignment. Importantly, these tools should augment—not replace—anatomical understanding and clinical judgement. Rural contexts will keep us honest: technology that fails offline, drains batteries by noon, or confuses the user will be abandoned. The winners will be simple, robust, and clinically meaningful.

In this issue of International Journal of Regional Anaesthesia, Biyani and Metta discuss the promising role of AI in addressing the challenges in image interpretation during ultrasound guided RA especially in the subset of patients with difficult sonoanatomy or deep/difficult blocks like neuraxial blocks [12]. They have comprehensively discussed various applications of AI in RA and the various pros and cons of use of AI for RA. They have aptly pointed out that the quality of AI generated data relies heavily on inputs provided by the operator. Notably, authors mention that AI tools are expensive and often impractical to use in resource-limited settings.

Contemporary medical practice aims towards precision based medicine and RA is not behind. Recent advances in pharmacogenetics and genomics hold promise to revolutionise RA and pain management through precision analgesia. A review article by Bhuvaneshwari and Diwan explores the current landscape, challenges, and potential of genomics-driven precision analgesia in perioperative and critical care settings [13].

Among the reasons for a growing interest in RA for oncoanaesthesia is its promising role of RA in preventing cancer recurrence by reducing the perioperative stress response, supporting immune function, and decreasing the use of opioid and volatile anaesthetics. Grewal et al. [14] appropriately notice that although RA reliably enhances pain management and perioperative recovery, its impact on cancer outcomes remains uncertain. The main reason cited in their article is the variability in study methods, confounding variables, and a scarcity of high-quality randomised controlled trials to draw definitive conclusions. Authors caution that until more solid evidence is available, personalised anaesthetic strategies are essential.

To conclude, the path of RA is not fixed linear progress forward but more of a pragmatic and dynamic one where individualised patient management is the goal with a focus on safety. Rural and remote RA practice has always centered on the principles of sound knowledge of anatomy and

physiology, portable equipment, creative thinking and deep concern for patient safety. Modern RA practice has only amplified those values and techniques to further the cause of patient safety and best outcomes. Incorporating novel tools like ultrasound and artificial intelligence into the ethos of rural RA techniques has taken RA to new heights where it is now considered the foundational pillars of anaesthesia. Whether in a small remote clinic or an urban hi-tech facility, whether done on a high-end ultrasound machine or with a

handheld ultrasound, the essence of RA stays the same: precise, thoughtful care that supports natural physiology and helps patients recover well. The move from rural beginnings to cutting-edge technology driven practice is not a breaking free from the past but moving forward in the best possible way—a targeted, profound care while respecting patient physiology and empowering early recovery. To sum it up, the journey of RA from rural and remote roots to the current leading edge era is not a departure; it is a reunification.

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