The role of regional anaesthesia in the management of acute pain

Philip Hassell
James Stimpson

Abstract

The role of regional anaesthesia in anaesthetic practice has become essential to enhance acute pain control, minimize the use of systemic opioids and optimize the multidisciplinary approach to enhanced recovery programmes. They are used as powerful tools to enable ambulatory surgery in a wide variety of surgical specialties and reduce the transition from acute to chronic pain. Adjuncts to local anaesthetics can be used to prolong block time and target nociception specifically allowing motor function to remain.

Keywords Acute pain; adjuvants; complications; local anaesthetics; regional anaesthesia

Royal College of Anaesthetists CPD Matrix: 1D02, 2E01, 2G01, 2G04

The WHO analgesic ladder is an internationally accepted pharmacological, step-wise approach in the management of pain of increasing severity (Figure 1). During each step, consideration must be given to the addition of adjunct medications; the description of the use of regional anaesthesia (RA) is not often included yet can provide substantial analgesia, especially in the cohort of postoperative patients. As the level of pain increases, the use of RA becomes more beneficial, especially when strong opioid side effects become problematic. This article will explore the use of RA in the management of acute, postoperative pain.

RA aims to deposit local anaesthesia around specific nerves, groups of nerves or within tissue planes in which nerves lie, to provide temporary blockade of autonomic, sensory or motor blockade to that part of the body to which the nerve or nerves innervate.

Postoperative pain is mostly predictable; therefore an estimate of pain severity can be calculated and optimum analgesia obtained using the WHO analgesia ladder with the addition of adjuncts to regular medications and the use of regional anaesthesia.

Philip Hassell *is an ST6 in Anaesthesia and Intensive Care Medicine at the Queen Elizabeth Hospital, King's Lynn, Norfolk, UK. Conflicts of interest: none declared.*

James Stimpson *is a Consultant Anaesthetist and Lead in Regional Anaesthesia at the Queen Elizabeth Hospital, King's Lynn, Norfolk, UK. Conflicts of interest: Dr Stimpson has received honoraria to deliver educational material for the University of East Anglia, and teaches on courses organized by B-Braun.*

Regional anaesthesia in comparison to systemic analgesia

RA is a powerful adjunct in postoperative pain, particularly in the postoperative setting where afferent nociception from the operative site can be significantly reduced or temporarily ceased. The adverse effects of acute postoperative pain are outlined in Table 1.

The advantages to RA include exceptional analgesia, avoidance of opioids and in some instances general anaesthesia, prevention of chronic post-surgical pain and early ambulation; whereas the disadvantages include training time, equipment, invasive procedure, limited duration without catheter techniques, motor block, nerve damage, haematoma and infection.

Complications associated with regional anaesthesia

As with every medical intervention, there is an associated risk. This can vary with type and location of RA performed but also substantially with operator expertise and to a lesser extent, patient anatomy and anatomical variations.

Regional Anaesthesia UK (RAUK)[2] recommend that the consent process must include offering the patient an information leaflet specific to the intended block to be performed at the preoperative assessment, explaining the benefits of a regional technique, alternative options to a regional technique (usually a general anaesthetic), the use of nerve stimulator and associated twitch sensation and/or the use of ultrasound, failure and backup plan, and specific complications or side effects (Horner's syndrome with interscalene block and pneumothorax with supraclavicular block temporary nerve damage (1:10) and permanent nerve damage [the Royal College of Anaesthetists estimates this to be 1:2000 to 1:5000]).[3]

The exact aetiology of neuronal injury is varied, but is increased in patients with pre-existing neuropathy and with prolonged exposure to high concentrations of local anaesthetic. The sound application of anatomy, the use of ultrasound with or without the concomitant use of a nerve stimulator and good communication with the anaesthetic team can reduce the incidence of intrafascicular injection. Table 2 demonstrates the advantages and disadvantages of RA in comparison to other analgesic strategies.

The deposition of local anaesthesia around certain nerves can produce unfavourable side effects, although they should not be classified as complications, for example, phrenic and stellate ganglion blockade (causing shortness of breath, especially in patients with pronounced respiratory disease and Horner's syndrome, respectively) when performing an interscalene block.

Complex patients and specific comorbidities

The patient with severe respiratory disease

Opioid-based analgesic regimes can often produce unwanted side effects in patients with severe respiratory disease. Regional anaesthesia can offset these side effects and allow patients to fully comply with nursing and physiotherapy care, especially in relation to manoeuvres which decrease atelectasis; specifically following laparoscopic, abdominal and intrathoracic surgery. Patients who have sustained thoracic trauma can also benefit by reducing their likelihood of developing lower respiratory tract infections and requiring invasive ventilatory support.

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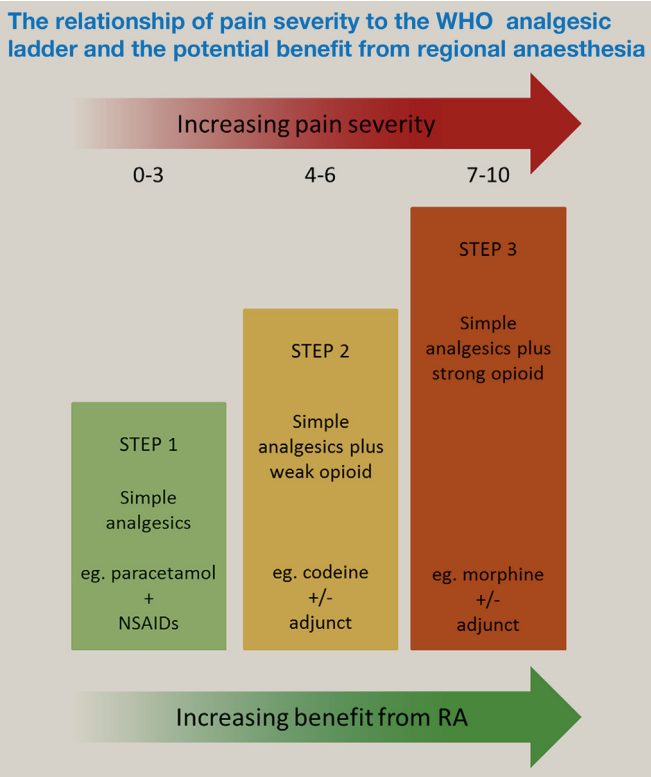

Figure 1

Regional anaesthesia is not without its complications, however. Interscalene blocks can compromise respiratory function by blocking the phrenic nerve and is relatively contraindicated in severe respiratory disease or when the patient is relying on the ipsilateral lung for their respiratory support. Equally, both the supraclavicular and infraclavicular approaches to the brachial plexus carries the risk of pneumothorax.

The older patient

Age-related pharmacokinetic and pharmacodynamic changes must be considered when using opioid analgesics. Absorption of oral morphine is greater in the elderly and would normally undergo high first-pass metabolism; however, the reduction in activity of cytochrome P450 3A4 results in decreased systemic clearance and increased elimination half-life. This can lead to iatrogenic over-prescribing, confusion, drowsiness and respiratory depression.[5]

Consequently, fascia-iliaca or femoral nerve blocks performed on patients with a fractured neck of femur soon after their admission has led to improved pain scores, less use of opioid analgesics and less delirium compared with opioid analgesics in conjunction with standard non-opioid analgesia.[6] Epidural analgesia remains the gold standard of care following major surgery, especially for open operations involving the abdomen for this cohort of patients.

The paediatric patient

The paediatric population often requires surgical intervention for a myriad of problems. Children have a varying degree of understanding to their course of treatment and its associated pain. Neonates have an immature CYP450 enzyme subsystem and the paediatric population have larger volumes of distribution compared with adults, meaning that repeated doses can lead to toxicity.

All types of regional technique are performed under general anaesthesia. Single injection for peripheral nerve or fascial plane blocks have been performed successfully in both upper and lower limbs.

Limited data are available in the paediatric population regarding plasma levels associated with continuous infusions of local anaesthetic for peripheral nerve and fascial plane blocks. As such these are possible, but caution to minimize the plasma concentration ensures their relative safety.

Adjuvants are alpha-2 adrenoceptor agonists, e.g. clonidine, using the minimum possible to produce the effect while minimizing any adverse effects.[7]

The opioid-tolerant patient

Patients who have been receiving opioids or opiate analgesics for a prolonged period of time can develop tolerance, physical dependence and hyperalgesia, making adequate analgesia in this sub-group of patients particularly challenging. This is currently thought to be due to a neuronal adaptation phenomenon involving a complex series of molecular and cellular events — including receptor desensitization, down-regulation, and internalization.

In this context, regional anaesthesia allows the patient to continue with their regular opioid regime while providing additional analgesia. The use of catheter techniques will allow prolonged sensory block and minimize complex increases to the opioid analgesics already required.

The patient with cancer

Regional anaesthesia has the ability to significantly enhance pain control in the peri-operative period, especially in patient groups who are anxious and already receiving opioid analgesics. While it was previously thought that regional anaesthesia reduced cancer recurrence rates by suppressing the neuroendocrine response to surgery and minimizing the opioid-induced immunosuppressant actions of systemic opioids, meta-analyses are now concluding that there is no overall benefit in survival, recurrence-free survival and biochemical recurrence-free survival.[8] However, individual studies have shown some benefit and further research is required to properly evaluate the role regional anaesthesia may play in cancer recurrence.

The patient undergoing major surgery

Regional anaesthesia has become an integral part of enhanced recovery after surgery (ERAS) regimes. Almost all surgical specialties have ERAS programmes which decrease intraoperative blood loss and reduce the need for blood transfusion, the need for systemic opioids, nausea and vomiting as well as a reduction in postoperative pain.

Patients who are enrolled on to ERAS pathways are treated with a multidisciplinary approach and subsequently can engage with physiotherapy much sooner after their operations, reducing their hospital stay, hospital-acquired infections and VTE risk.

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Adverse effects of acute postoperative pain[1]

System	Effect
Cardiovascular	Increased sympathetic nervous system activity, tachycardia, hypertension, increased myocardial oxygen demand
Respiratory	Decreased ability to cough, decreased FRC, atelectasis, V:Q imbalance, hypoxaemia
Gastrointestinal	Decreased GI motility, ileus
Endocrine	Increased catabolic hormones (cortisol, catecholamines, angiotensin II), decreased anabolic hormones (insulin)
Renal	Sodium and water retention, increased excretion of potassium
Haematological	Decreased cellular and humoral immune function, hypercoagulable state
Metabolic	Insulin resistance, increased gluconeogenesis and glycogenolysis, hyperglycaemia, muscle catabolism
Psychological	Anxiety, disrupted sleep, social isolation, helplessness, risk factor for chronic post-surgical pain

Table 1

Transition from acute to chronic pain

The use of RA aims to block the transmission of acute afferent pain signals thereby reducing central neuroplasticity which is often demonstrated in the transition from acute to chronic pain.[9]

Drugs and adjuvants

The amide local anaesthetics lidocaine, bupivacaine and ropivacaine are most commonly used for regional anaesthesia. Their mechanism of action is by diffusing within the nerve axon in the unionized state and binding to an open sodium channel once they have become ionized, inhibiting propagation of pain transmission via Rexed laminae to the spinal cord. The local anaesthetics have been compared in Table 3 and the most appropriate can be selected dependent on the situation required.

Both the duration and density of the block can be manipulated with the use of adjuvant drugs. Alpha-2 adrenoceptor agonists and steroids are currently used to prolong duration. Clonidine used at a dose of 0.5 μg/kg to a maximum of 150 μg can significantly prolong block duration; larger doses may cause hypotension on ambulation.[10] Dexmedetomidine has been shown to further increase block duration and reduces perineural inflammation in animal studies, although expense and availability limit this use in the UK.

Dexamethasone has been shown to provide a 37% increase in block duration, marginally longer than with intravenous use at the time of block administration.

Perineural ketamine has been shown to increase the incidence of hallucinations and drowsiness in the postoperative period and is not recommended. Adrenaline can cause compromise to endoneural blood flow and increase neurotoxicity; however, it still has a role to aid intravenous catheter location.

There is current research into novel delivery systems for local anaesthetics (liposomal, microspheres and cyclodextrin systems) to prolong bioavailability. The liposomal lipid vesicles have the advantage of acting as a drug reservoir with low bioavailability; however, the metabolites of such systems have the potential to produce their own toxicity. Microspheres, manufactured from biodegradable polymers, have shown an increase in duration of sciatic nerve blocks to a range of 10 hours to 5 days, and cyclodextrins can accommodate guest molecules within their hydrophobic internal cavity.

Novel routes and new concepts

The majority of anaesthetic departments now have access to high quality ultrasound machines for peripheral nerve block placement. This allows the targeting of specific nerves, groups of nerves or plane blocks to achieve effective analgesia and improve

A comparison of regional anaesthesia with other acute pain management options[4]

Analgesic method	Advantage	Disadvantage
Regional anaesthesia	Targeted, preventive for CPSP	Training, equipment, invasive
Paracetamol	Few side effects	Rare, but harmful toxicity
NSAIDs	Anti-inflammatory action	GI ulceration, renal dysfunction
Opioids	Effective, multiple preparations and routes	Constipation, nausea, sedation, respiratory depression, delayed gut motility
Ketamine	Effective in opioid-resistant pain, preventive in CPSP	Dysphoria, hallucinations
Gabapentinoids	Reduce opioid side effects	Not effective for all pain, drowsiness
IV lidocaine	Effective	Toxicity, continuous monitoring
Clonidine	Effective, reduces nausea	Hypotension, bradycardia
Dexamethasone	Effective but small efficacy	Hyperglycaemia
Magnesium	Anti-IL6 and TNF-α, reduction in opioid requirements	Vasodilatation, reduction in platelet aggregation, toxicity

Table 2

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Properties of the most commonly used local anaesthetics in the UK

Drug	Onset of the action (mins)	Duration, without adrenaline (hours)	Maximum dose, without adrenaline (mg/kg)	Special considerations
Lidocaine	5–10	2–4	3	Caution when using 2%
Bupivacaine	10–30	18–24	2	Most cardiotoxic due to myocardial binding
Levobupivacaine	15–30	18–24	2	
Ropivacaine	14–18	14–18	3	Less motor block compared with equal concentrations of bupivacaine

Table 3

motor function in the perioperative period. Suprascapular nerve blocks alone have been shown to alleviate shoulder pain when compared with sub-acromial decompression or injection and erector spinae catheters have been used to alleviate pain from rib fractures providing a unilateral block and do not carry the same risk as insertion of a paravertebral block or thoracic epidural, both of which would be impossible without high quality ultrasound images.

Continuous catheter techniques, using a weak concentration of local anaesthetic preferentially blocking nociception while leaving motor function intact, have been used for femoral nerve blocks following hip surgery and interscalene following shoulder replacement surgery. Patients can be discharged home, with careful follow-up by specialist nurses, resulting in an improvement in patient satisfaction, hospital-acquired infections and health economics.

Time differential blocks are becoming more common to anaesthetize areas of the body for differing lengths of time. For example, a short-acting axillary brachial plexus block to cover tourniquet pain with a long-acting forearm block for post-operative analgesia for hand surgery and short-acting interscalene nerve block with a longer-acting suprascapular nerve block for shoulder surgery.

Economics and opportunity

Carefully selected population groups can have their surgery performed as day case procedures and discharged with appropriate follow-up following RA. This not only improves patient satisfaction and reduces the rate of hospital acquired infections, but also improves medical economic practice including a reduction in hospital length of stay, reduction in blood product use and unanticipated day surgery admissions due to pain control. Where pain control is likely to be required for several days, regional catheter techniques can be employed and the patient discharged home with the catheter in-situ with careful follow-up from specially trained pain nurses. ◆

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