



Regional anaesthesia and outcomes

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Key points

- Regional anaesthesia (RA) reduces acute pain, chronic pain after some surgical procedures, postoperative nausea and vomiting, and pulmonary complications.
- RA can reduce length of stay and improve operating department throughput.
- Although RA confers short-term functional benefits, these are generally not sustained.
- Combined general anaesthesia and epidural analgesia may increase the incidence of adverse cardiac events.
- Some studies have shown RA to be associated with a reduction in cancer recurrence, blood-transfusion requirements, surgical site infections, ICU admission, and mortality; however, these associations must be treated cautiously.

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Outcomes are of major importance to patients, healthcare providers, and institutions, and the perioperative team must aim for the best possible outcome for every patient. Knowledge of both outcome benefits and risks is also essential for informed consent. Regional anaesthesia (RA) has long been associated with better analgesic outcomes than general anaesthesia (GA) with systemic opioids, but the evidence that RA generates further outcome benefits is less certain.^{1–3} It can be a challenge to study the effects of RA on various patient-, surgical-, and institutional-related outcomes, as GA has become much safer, and surgical equipment, techniques, and pathways have also improved significantly. The innumerable variety of RA techniques and modifications thereof, the relatively recent advent of ultrasound guidance in place of traditional 'blind' techniques, and whether or not RA is used alone or in conjunction with sedation or GA can further complicate the picture. Hence, we are increasingly dependent on database analyses and observational studies, as well as traditional randomized trials to inform debate. For neuraxial anaesthesia and analgesia, contemporary data appear to favour RA compared to GA for some of the most important outcomes studied.² However, less evidence exists for peripheral nerve blocks (PNBs).⁴ It is not possible to examine every RA technique and operation in turn; instead, this article aims to provide a broad and balanced overview of the available evidence for a variety of outcomes relevant to the patient, the surgeon, and the institution.

Patient outcomes

Acute pain

Epidural analgesia, regardless of the agent used, the type of surgery, or the method of pain assessment, provides superior analgesia to parenteral opioids.¹ Similarly, PNBs, when used appropriately, provide better analgesia and reduce both opioid consumption and opioid-related adverse effects. From humanitarian and patient-satisfaction perspectives, superior

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pain control is one of the most significant outcome benefits of RA. However, the control of acute pain also reduces many of the negative physiological and psychological sequelae associated with surgical stress (Table 1), which, in theory, may underpin any additional benefits of RA.

One limitation of single-shot regional blocks is the phenomenon of rebound pain, occasionally necessitating readmission. A perineural catheter-based continuous infusion of local anaesthetic extends the analgesic benefits of a single-shot PNB, or alternatively, additives may be used to prolong a block. Other strategies to reduce this potential problem are appropriate staff and patient education to ensure prescription, administration, and compliance with regular multimodal analgesia before block regression.

Chronic pain

The incidence of chronic post-surgical pain (CPSP) varies with the surgical procedure, but increased severity of acute postoperative pain is a recognized risk factor. A recent Cochrane review demonstrated that CPSP 6 months after thoracotomy was reduced by perioperative epidural compared to systemic analgesia.⁵ Similarly, paravertebral blocks were of benefit after breast surgery. Evidence for RA could not be collated for other surgeries because of either heterogeneous study characteristics or RA techniques. Ultimately, RA and the timing of the intervention are only two of the many factors that may

influence the development of CPSP, but it does appear that RA may have a role.

Postoperative nausea and vomiting

Postoperative nausea and vomiting (PONV) can lead to longer post-anaesthesia care unit (PACU) stays, delayed day surgery unit (DSU) discharge, and unplanned hospital admission. PONV remains a major concern for patients before surgery and is a common cause of patient dissatisfaction. Meta-analysis has demonstrated that RA reduces the risk of PONV compared to GA, although several of the included trials of GA did not utilize prophylactic anti-emetics. Nevertheless, RA, by avoiding GA and/or reducing postoperative opioid requirements, is recommended in PONV guidelines.⁶ Spinal anaesthesia does not always reduce PONV compared to GA, possibly because of hypotension, intrathecal opioid additives, or sympathetic blockade resulting in a vagally mediated overactivity of the gastrointestinal (GI) system. Conversely, PNB alone, which does not have these centrally mediated side effects, has consistently been shown to be beneficial.

Sleep quality

A reduction in both total sleep duration and rapid-eye-movement (REM) sleep, as well as fragmented sleep, can lead to increased nociception. This impacts on both enhanced recovery programmes and subsequent sleep therefore continuing the cycle. A rebound increase in REM sleep has been associated with myocardial infarction, stroke, and haemodynamic instability. Using RA and multimodal analgesic techniques does not, however, completely prevent this interruption of REM sleep. It is likely that the magnitude of the surgical insult itself, the use of opioids and other medications, and the postoperative sleep environment have more effect on sleep quality than the type of anaesthesia. Obstructive sleep apnoea is also associated with increased perioperative complications: using a regional technique in place of GA reduces complications in these patients.⁷

Postoperative cognitive dysfunction and delirium

Postoperative cognitive dysfunction (POCD) differs from delirium (itself a risk factor for POCD) and has been defined as the long-term disabling deterioration in cognitive function following surgery. POCD can result in emotional distress to patients and relatives, impairment of recovery, prolonged hospital stay, and increased social and physical care requirements in the community. Whilst RA reduces pain and opioid consumption, modifies the surgical stress response, and may allow GA to be avoided, the most recent meta-analysis concluded that there is still no evidence that RA reduces POCD compared to GA.⁸ Any analysis of POCD is complicated by heterogeneous assessments and definitions, as well as the use or not of sedation with RA, but there is also a suggestion that GA may be neuroprotective. A separate Cochrane review also failed to show any difference between central neuraxial blockade (CNB) or GA, and the risk of acute confusional state after a hip-fracture surgery.

Cancer recurrence

By reducing both the surgical stress response and opioid consumption, RA can indirectly improve the host immune

Table 1 Adverse effects of acute postoperative pain

Physiological
Cardiovascular
<ul style="list-style-type: none"> • ↑ Sympathetic-nervous-system activity • Tachycardia • Hypertension • ↑ Myocardial O₂ demand • ↓ Myocardial O₂ supply • Risk of cardiac ischaemia
Respiratory
<ul style="list-style-type: none"> • ↓ Ability to cough • ↓ Functional residual capacity • Atelectasis • Ventilation: perfusion imbalance • Hypoxaemia
Gastrointestinal
<ul style="list-style-type: none"> • ↓ GI motility • Ileus
Endocrine
<ul style="list-style-type: none"> • ↑ Catabolic hormones (cortisol, adrenocorticotrophic hormone, growth hormone, catecholamines, angiotensin 2, and glucagon) • ↓ Anabolic hormones (insulin and testosterone)
Renal
<ul style="list-style-type: none"> • Sodium and water retention (↑ catecholamines, ↑ activation of renin–angiotensin–aldosterone system, ↑ antidiuretic hormone) • ↑ Excretion of potassium
Haematological
<ul style="list-style-type: none"> • ↓ Cellular and humoral immune function • Hypercoagulable state
Metabolic
<ul style="list-style-type: none"> • Insulin resistance, ↓ insulin secretion • ↑ Gluconeogenesis, ↑ glycogenolysis, hyperglycaemia • Muscle catabolism • ↑ Lipolysis
Psychological
<ul style="list-style-type: none"> • Anxiety • Disrupted sleep • Social isolation • Helplessness • Pain catastrophisation • Risk factor for developing chronic post-surgical pain

response to tumour cells. Laboratory data also suggest that local anaesthetic agents directly promote apoptosis and reduce both proliferation and invasion of cancer cells. Retrospective data suggest that paravertebral analgesia reduces breast-cancer recurrence. However, the evidence is more mixed for an effect on prostate- and colorectal-cancer recurrence when an epidural has been combined with GA. A recent systematic review indicated that perioperative RA may improve survival without reducing cancer recurrence, but the quality of evidence is low. Ultimately, there is as yet no definitive evidence demonstrating a benefit of RA in cancer recurrence.⁹ RA is unlikely to be the sole factor, and indeed volatile anaesthetic agents have been shown to have a negative effect on immune function and cancer spread. Therefore, any benefit of RA may simply reflect a reduction or avoidance of volatile anaesthetic agent use.

Morbidity

Pulmonary

Epidural analgesia combined with GA reduces pulmonary complications in thoracic, abdominal, and lower-limb procedures, and is also of proven benefit in patients with pre-existing pulmonary disease.^{2,10} Spinal anaesthesia also reduces pulmonary complications compared to GA. Logic would suggest that the use of a PNB where possible, with avoidance of GA and reduced opioid consumption, would reduce pulmonary complications, but there are no large studies on this topic. Phrenic nerve palsy and pneumothorax are a risk with some upper-limb PNB approaches, which may limit their appropriateness in some situations.

Cardiac

The need to ensure adequate coronary oxygen delivery to meet demand is no different whether RA or GA is utilized. In two recent analyses of elective lower-limb arthroplasty surgery, one study found less cardiovascular events using neuraxial anaesthesia alone compared with GA, whereas in the other this was a non-significant trend.^{11,12} In hip-fracture surgery, only some studies demonstrate a benefit of spinal anaesthesia compared with GA. It is clear, however, that CNB-mediated hypotension is more marked when CNB and GA are used in combination. Accordingly, combined epidural and GA has been associated with an increased incidence of perioperative myocardial infarction following major truncal and lower-limb surgery, albeit not increased mortality.² The optimal management of epidural analgesia after surgery in the ward or high-dependency environment can be challenging, and it is unclear to what extent epidural-related hypotension after surgery may contribute to complications. Ultimately, when using neuraxial techniques the emphasis must be on appropriate local anaesthetic dosing and haemodynamic monitoring, with timely pharmacological management of CNB-related hypotension both intra- and postoperatively. It must also be remembered that many patients are taking either anticoagulant medications, which increase the rare risk of neuraxial haematoma, or antihypertensive agents that increase the risk of hypotension and spinal cord or myocardial ischaemia. There are no large trials examining PNB and cardiac outcomes.

Cerebrovascular complications

For patients undergoing carotid endarterectomy, the incidence of stroke is not significantly reduced when using a local

anaesthetic technique compared to GA, albeit the RA and surgical techniques utilized in the largest study varied widely.¹³ In orthopaedic surgery, neuraxial anaesthesia may reduce cerebrovascular complications, but no other data consistently suggest that CNB (or PNB) influences cerebrovascular complications.¹¹

Deep venous thrombosis/pulmonary embolism

Before the introduction of deep venous thrombosis (DVT) prophylaxis, CNB reduced the incidence of both DVT and pulmonary embolism. However, in the current era of routine thromboprophylaxis, it is unclear whether or not RA offers any additional protective benefit.^{2,14} Whilst motor-sparing PNBs facilitate ambulation, there is no robust evidence that PNB offers an additional benefit.

GI function

Epidural analgesia reduces pain and opioid consumption, and has been shown to reduce the duration of both ileus and time to first flatus. There has been concern that epidural analgesia increases the risk of anastomotic leakage perhaps caused by either gut hypo-perfusion or by an increase in peristalsis secondary to the associated sympathectomy, but this has not been consistently demonstrated.

Urinary retention

Postoperative urinary retention (POUR) can lead to delayed discharge, infection, adverse autonomic events, and urodynamic dysfunction. Spinal anaesthesia, particularly if intrathecal opioids are used, increases the risk compared to GA. However, when using low-dose spinal techniques or employing shorter-acting spinal local anaesthetics, such as prilocaine without opioids, some studies demonstrate no difference in POUR compared to GA. Logically, PNB should reduce the risk compared to GA, which may also affect bladder function, but no large studies exist.

Blood loss

The incidence of requiring a blood transfusion appears to be less in major truncal and lower-limb surgery with both CNB alone and combined CNB–GA compared to GA.² It is not always clear in some studies whether this is independent of CNB-related hypotension.

Intensive care unit admission

Recent meta-analyses suggest that both CNB alone and combined epidural and GA reduce ICU admission, most likely due to a reduction in pulmonary complications.²

Mortality

The increased use of RA in obstetric anaesthesia is credited with a reduction in anaesthetic maternal mortality over the past three decades. Outwith obstetrics, meta-analyses of contemporary data comparing either CNB to GA, or CNB combined with GA to GA alone generally fail to show a difference in mortality.² Large population analyses, which have inherent limitations, do suggest that CNB techniques compared to GA particularly in lower-limb arthroplasty surgery may reduce mortality, but the absolute difference, if real, is small.^{11,12} Recent retrospective data suggest that, in abdominal aortic surgery, the addition of an epidural to GA improves the 5 yr survival compared to GA alone.¹⁵ The risk of GA varies directly with American Society of Anesthesiologists

physical status, but there is no clear evidence that using RA in high-risk patients influences outcome.¹⁶ PNB avoids the haemodynamic compromise of CNB, and theoretically may be safer than CNB or GA in high-risk patients, but there is only anecdotal evidence to support this, albeit as experts PNB would be our choice. A regressing or inadequate block in such cases, however, may be more dangerous than a well-conducted GA.

Patient satisfaction

Patient satisfaction is increasingly important and can be viewed as an indicator of the quality of anaesthetic care. It is influenced by many factors, but well-validated tools for measuring satisfaction with RA are lacking. Compared to placebo or alternative analgesic techniques, satisfaction is generally higher with both PNB and CNB. One meta-analysis demonstrated that PNB, but not CNB, was associated with higher patient satisfaction in the DSU compared to GA, because although pain scores were low in both groups, only PNB was associated with decreased PONV.¹⁷

Surgical outcomes

Surgical outcomes are clearly influenced by many factors, but there has always been interest in whether the anaesthetic technique may have an impact.

Lower-limb arthroplasty

PNB improves postoperative analgesia, which in turn facilitates earlier physiotherapy and joint mobilisation. However, despite evidence that perioperative PNB may increase the range of joint movement and increase walking distances up to 6 weeks or more after operation, there are no data showing that RA improves long-term functional outcome or health-related quality of life 1 yr after major lower-limb arthroplasty.^{2,18} Furthermore, PNB has been linked with falls in lower-limb surgery due to impaired proprioception, motor block, and muscle weakness. The move towards more motor-sparing blocks, such as the adductor canal block, or the use of local infiltration techniques may reduce this risk.

Vascular surgery

Compared to GA, CNB is associated with sympathetic blockade, which in turn increases blood flow and reduces certain pro-thrombotic coagulation factors. In lower-limb arterial reconstruction surgery, CNB has been shown to reduce the number of re-grafting or thrombectomy procedures prior to discharge. Other studies have similarly confirmed early but no long-term differences in graft failure with CNB compared to GA. In arteriovenous-fistula-formation surgery, RA compared to local anaesthesia has been shown to have a long-lasting benefit, with patency of arteriovenous fistulae at 3 months significantly higher in the RA group compared to those fistulas created under local anaesthesia.¹⁹ Early failure is reduced in the RA group possibly due to a reduction in thrombosis secondary to the RA-mediated sympathetic block, which increases fistula blood flow and reduces vasospasm. This early benefit persists, representing one of the only randomized studies to demonstrate a long-lasting surgical outcome benefit directly linked to RA.

Surgical site infection

Surgical site infection (SSI) remains a significant cause of morbidity and mortality in surgical patients. By influencing the immune system both directly and indirectly as described earlier, it has been postulated that RA could have a beneficial effect. This is supported by a recent meta-analysis incorporating a variety of surgical specialities, which demonstrated a reduction in SSIs where CNB was used either alone or in combination with GA.² This differs, however, from earlier individual studies of orthopaedic and obstetric patients where no difference was demonstrated.

Institutional outcomes

Length of stay and unanticipated day-surgery admission

Length of stay (LOS) is sometimes used as a surrogate measure of efficiency, with a shorter LOS implying fewer postoperative complications. Enhanced recovery protocols aim to reduce LOS through a multidisciplinary effort, and many incorporate RA to reduce both acute pain and PONV, as well as to improve mobilisation. Accordingly, either RA alone or RA in combination with GA appears to reduce LOS when combined data from orthopaedic, vascular, thoracic, gynaecology, urology, and general surgery are examined.² The difference, however, in this largest meta-analysis to date was measured in hours rather than days. In the DSU, modern GA techniques allow for rapid recovery, yet the most common anaesthetic-related causes of unanticipated admission or delayed discharge remain pain, somnolence, and PONV, all of which are reduced by RA. The overall unanticipated admission rates are low in day surgery, but an increased risk has been shown with GA compared to RA.

Operating department throughput

There are many factors in the patient journey that influence throughput, but PNB has been shown to be of benefit by reducing nursing staff interventions and allowing bypass of, or reducing the time spent, in PACU. A meta-analysis of studies comparing RA to GA for a variety of DSU surgical procedures found that PNB did not reduce the actual overall time spent in the DSU because of increased anaesthetic induction time, although this could be offset by working in parallel using either a block room or the anaesthetic room.¹⁷ The same analysis suggested that CNB increased the total time until discharge in the DSU possibly because of prolonged motor block, nausea, or delayed urinary voidance. Unfortunately, more recent studies using shorter-acting local anaesthetics, such as prilocaine or chloroprocaine, or lower-dose techniques were not included in the meta-analysis.

Cost

Healthcare economics is a complex issue, but reducing inpatient LOS, blood transfusion, intensive care unit admissions, and unanticipated day-surgery admissions can reduce healthcare costs. Furthermore, RA techniques, such as continuous perineural catheters, improve postoperative analgesia to the extent that potentially painful inpatient procedures can be undertaken as ambulatory cases, which may

have secondary benefits of generating additional inpatient bed space or saving costs. RA block rooms have also been shown to reduce turnover time and increase the number of cases done per day, increasing theatre utilisation and efficiency.

Summary

Any general or regional anaesthetic technique must always be tailored to both the individual patient and the operation, taking into account the potential benefits and risks. The contribution of the individual anaesthetist in managing the RA (or GA) technique effectively and safely in order to achieve a good outcome must not be underestimated. Nevertheless, evidence does suggest that RA confers some outcome benefits beyond reducing acute pain. These include a reduction in chronic pain after some procedures, less PONV, and a clear reduction in pulmonary complications. RA has also been linked with a reduction in cancer recurrence, blood transfusion, SSI, intensive care unit admissions, and even a small reduction in mortality in some cases, but these data must be treated more cautiously. When CNB is used alone rather than in combination with GA, the benefits are often greater. Logically, utilising PNBs without GA and therefore avoiding CNB-mediated hypotension may offer the most benefit, yet the potential outcome benefits of PNBs are the area least studied.

Declaration of interest

A.J.R.M. is an Editorial Board Member of *BJA Education*.

MCQs

The associated MCQs (to support CME/CPD activity) can be accessed at www.bjaed.org/cme/home by subscribers to *BJA Education*.

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