Does regional anaesthesia improve outcome?

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Abstract

This review examines the recent evidence of an impact of regional anaesthesia on important clinical outcomes. Evidence was obtained from a variety of studies, with increasing numbers of analyses of large databases being prominent. The benefits and limitations of these approaches are considered in order to provide a context for interpretation of the data they generate. There should be little argument that correctly performed and appropriately used regional anaesthetic techniques can provide the most effective postoperative analgesia for the duration of the block, but the majority of studies suggest that this does not translate into improved longer-term surgical outcomes. The evidence for reduced incidence of major complications when regional anaesthesia is compared with, or added to, general anaesthesia is mixed. There appears to be a small effect in reducing blood loss during major joint arthroplasty. Some, but not all, studies demonstrate a reduced incidence of respiratory and infective complications with regional anaesthesia, but the effect on cardiovascular complications is variable. There are even some data consistent with a hypothesis that general anaesthesia may be protective against postoperative cognitive dysfunction. In conclusion, there is probably no generally applicable benefit in long-term outcomes with regional anaesthesia. More likely is an interaction between patient factors, the surgical procedure, and the relative capability of the anaesthetist to manage different types of anaesthesia.

Key words: death; regional anaesthesia, complications; regional anaesthesia, outcomes; surgery, complications; surgery, outcomes

Editor’s key points

- Evidence for reduced incidence of major complications when regional anaesthesia is compared with general anaesthesia is mixed.
- Initial functional gain with improved acute pain management but no long-term functional difference appears to be a typical pattern.
- Patient factors are likely to interact with the type of anaesthetic in determining outcome, but identifying potential beneficiaries will require further study.
- A clear and consistent benefit of regional anaesthesia on long-term outcome remains elusive.

In the equivalent supplement in 2011, Kettner and colleagues considered a very similar question: does regional anaesthesia improve outcome? They concluded that it was very difficult to provide an informed, evidence-based answer to this question because of the lack of prospective randomized controlled trials and meta-analyses. The problem was not a lack of research in regional anaesthesia but rather the research questions that had been addressed by that research. A recently published systematic narrative review of the literature between 2003 and 2013, which examined the influence of peripheral regional anaesthetic techniques on surgical outcomes, came to a similar conclusion. Selected results of a search of publications focusing on research into regional anaesthesia in the British Journal of Anaesthesia...
since 2013 suggests that research into technical aspects,3,4 dosing studies,5,6 and adjuvant medications7,8 is still prominent.

One of the self-imposed constraints of the articles by Kettner and colleagues1 and Kessler and colleagues2 was restriction to class one evidence, namely randomized controlled trials and meta-analyses. In this short review, I have not been so restrictive in the type of study included nor have I restricted my subject matter to peripheral regional blocks. I have not included studies involving obstetric analgesia and anaesthesia or paediatric research. I have also excluded the effect of type of anaesthesia on cancer recurrence and other cancer outcomes because this subject has been comprehensively covered in a recent special issue of the British Journal of Anaesthesia3 and in an accompany review in this issue.10

The articles cited were identified using a PubMed search combining conduction anaesthesia (MeSH term) OR regional anaesthesia (text word) AND surgery (MeSH term) with outcomes. Outcomes included intraoperative complications (MeSH), postoperative complications (MeSH), outcome (text word), death (text word), effectiveness (text word), pain (text word), and length of stay (text word). The reference lists of relevant articles and the ‘similar articles’ function on PubMed were used to identify further papers (Table 1). Before I discuss the evidence for the effect of regional anaesthesia on outcomes in different types of surgery, I will first comment on the types of studies that generated the evidence and also the different outcomes that have been explored.

Types of study

I identified seven randomized controlled trials from single centres in the past 5 yr that I considered of interest.11–17 My literature searches did identify other studies describing themselves as randomized controlled trials but I did not consider them further if they contained major methodological flaws (lack of randomization, no control group, disregard of equipoise, etc) or the outcome was not within my remit (see section on types of outcome below).

Four of these publications were the definitive reports of a randomized controlled trial.12,15–17 The remaining three papers11,13,14 were secondary publications reporting the analysis of long-term follow-up data of trials that had been previously published. Two of these trials illustrate the difficulty of conducting randomized controlled trials that try to address the benefits or otherwise of different types of anaesthesia. Parker and Griffiths16 compared general vs regional anaesthesia for hip fracture surgery, with a primary outcome of mortality. Throughout a 5 yr period, the hospital admitted 2200 patients with hip fracture and who were evaluated for inclusion in the trial. The majority of patients (1878) were excluded for a variety of reasons or did not meet inclusion criteria. Silbert and colleagues17 also looked at a population of older adults. The specific purpose of their study was to address whether anaesthesia or surgery per se was responsible for postoperative cognitive dysfunction. The study population was patients having extracorporeal shockwave lithotripsy, and they were randomized to receive either general anaesthesia or spinal anaesthesia without sedation. The trial was stopped after an interim analysis for futility suggested that adequate power could not be achieved in a realistic time frame. The tight inclusion and exclusion criteria, along with unpopularity of spinal anaesthesia without sedation, prevented efficient recruitment. It took 6 yr to recruit 98 patients.

I identified three multicentre randomized controlled trials.18–20 Only one of these,26 a comparison of general anaesthesia, regional anaesthesia, and local anaesthesia for endovascular aneurysm repair, was a study with the primary research question of the effect of type of anaesthesia on outcome. There was one publication18 reporting longer-term outcomes of a multicentre trial that had previously reported the short-term effects on pain and mobilization after total knee arthroplasty. The third paper was a secondary analysis of the POISE trial, with the objective of exploring the effects of β-blocker or placebo for prevention of cardiovascular complications in non-cardiac surgical patients with a high risk of cardiovascular complications.19 This secondary analysis involved the post hoc comparison of patients who had received any form of neuraxial block with those who had received general anaesthesia. Data from such secondary analyses must be interpreted with caution because of the inevitable bias associated with the non-randomized selection of the type of anaesthetic used. Leslie and colleagues26 used propensity score matching to limit the effect of such indication confounding, but it is important to understand that propensity scoring can only balance confounding factors that are known and recorded.

Of four meta-analyses, two were primary Cochrane reviews21,22 and one was an overview of Cochrane systematic reviews23 where the primary aim was to consider the comparison of regional and general anaesthetic techniques on outcome. The fourth meta-analysis24 was not focused on the type of anaesthetic but sought to identify all risk factors for postoperative delirium in older adults after surgery.

There were three papers that reported retrospective analyses of cohorts from single centres.25–27

The most notable feature of the recent literature in the field, however, is the number of papers involving retrospective analyses of large databases. Databases that have been mined for evidence that the type of anaesthetic can affect outcomes include a national database prospectively generated for patients with a fractured neck of femur,28 the database of the American College of Surgeons’ national surgical quality improvement programme29–34 and large administrative health-care databases.35–39 Such studies are crucially reliant on the quality of data contained within these databases. The structure of the database determines the effectiveness of any search strategy designed to extract relevant data as well, of course, the capability of the researcher designing the search strategy. In this respect, it is interesting to note that two publications29,30 involved analysis of the same database throughout the same time period and examining the same interventions and outcome. The first of these studies found 22 054 patients who had general anaesthesia and 4016 who had regional anaesthesia,29 whereas the other study found 20 670 patients who had general anaesthesia compared with 4046 patients who had regional anaesthesia.30 Another potential problem in using databases not originally designed for specific research purposes is that they may not incorporate vital data. An example of this appears to be the study of Neuman and colleagues,30 who were interested in the effects of anaesthetic technique on outcomes from hip fracture surgery. They used New York’s state-wide planning and research cooperative system database of hospital discharges and patient data, but it seems that they did not have confidence in the data defining the type of anaesthetic or there were incomplete data in this field. They therefore used information on whether the patient lived nearer to a hospital that tended to do more regional anaesthetics or a hospital that tended to do more general anaesthetics as a surrogate measure for the type of anaesthetic.

Benefits from using data derived from large databases include the potential to gain insights into rare events and the probability that results reflect the ‘real-world’ situation and can therefore be generalized to the population in question. The size of the
database in itself, however, does not overcome the pitfalls of comparing groups assigned by non-random allocation. Exactly as with post hoc analysis of data from randomized controlled trials, propensity scoring and other multivariate regression techniques can be used to account for confounding factors, but again the limitations of these statistical techniques must be appreciated.40–42

Types of outcome

There are broadly two types of outcome that I shall discuss. The first is whether regional anaesthesia has a positive benefit on the intended outcome of the surgical procedure. By excluding the effect of anaesthesia on cancer outcomes, I have in reality limited the applicable type of surgery to orthopaedic and trauma surgery. The second category of outcome is unwanted effects or complications of surgery. These range from death to cardiovascular or respiratory complications, chronic pain, postoperative cognitive dysfunction, infections, and blood loss or requirement for blood transfusion. For the majority of these complications, the outcome is heavily dependent on the nature of the surgery; any effect of the type of anaesthetic is likely to be specific for the different types of surgery. This is well illustrated by a Cochrane systematic review and meta-analysis of the effect of regional anaesthesia in preventing persistent pain.21 This meta-analysis sought evidence of a difference in persisting

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pain 6–12 months after surgery. The types of surgery were grouped into thoracotomy, limb amputation, breast cancer, laparotomy, and other. Any method of local or regional anaesthesia was included. The authors concluded that it was only appropriate to combine for analysis three studies investigating the effect of epidural analgesia after thoracotomy and two studies looking at paravertebral block after breast cancer surgery. For both situations, there was a beneficial effect on reducing persisting pain at 6 months after surgery. Epidural analgesia after thoracotomy was associated with an odds ratio of 0.34 [95% confidence interval (CI) 0.19–0.60]. For breast cancer surgery, paravertebral block was associated with an odds ratio of persisting pain at 6 months of 0.37 (95% CI 0.14–0.94). This latter finding was not supported by a randomized controlled trial of thoracic paravertebral block in patients having modified radical mastectomy.15

The principal outcomes were acute and chronic pain, and there was little difference between the groups in these, even though this trial included more patients than the total of the two studies included in the meta-analysis.15 21 There was an improved physical and mental health-related quality of life score in patients who received the thoracic paravertebral block compared with general anaesthesia; this may have arisen because of lower pain scores in those patients with paravertebral block who developed chronic pain.22

An outcome that may well be independent of the type of surgery, aside from cardiac surgery and neurosurgery, is postoperative cognitive dysfunction in the elderly. As discussed above, Silbert and colleagues12 attempted to address this issue in a randomized controlled trial of general anaesthesia vs spinal anaesthesia without any sedation for extracorporeal shockwave lithotripsy. Despite the trial being stopped after an interim analysis for futility, analysis of the data suggests a potential beneficial effect of general anaesthesia. Three months after surgery, the incidence of postoperative cognitive dysfunction was 6.8% (95% CI 1.4–18.7%) in the general anaesthesia group and 19.6% (95% CI 9.4–33.9%) in the spinal group (P=0.07). One interpretation of these data is that surgical stress is the cause of postoperative cognitive dysfunction and general anaesthesia provides a neuroprotective effect; this may be a hypothesis worth pursuing in future trials.

As with postoperative cognitive dysfunction, postoperative delirium might be presumed to be less frequent after regional anaesthesia compared with general anaesthesia. Scott and colleagues24 undertook a meta-analysis where the primary outcome of interest was the incidence of postoperative delirium in older adults (although the study included any patient >50 yr of age) having total hip or knee replacements. There was no statistically significant difference in the incidence of delirium between regional and general anaesthesia.

I shall now discuss the remaining outcomes according to the type of surgery.

**Major joint arthroplasty**

Although some studies persist in trying to determine the benefit or lack thereof of regional anaesthesia vs general anaesthesia, the research question in other papers is more nuanced. In these latter studies, it appears to be accepted (and quite reasonably so) that regional anaesthesia can produce the best postoperative analgesia. The next question is, therefore, does better postoperative analgesia translate into improved long-term function, and if so, what duration of superior acute pain management is required for a long-term benefit?

Carli and colleagues12 conducted a small randomized controlled double-blind trial in patients having total knee replacement under spinal anaesthesia. All patients received both femoral nerve and peri-articular knee catheters; patients received local anaesthetic through one of the catheters and saline through the other. There were 20 patients in each group, and the femoral nerve local anaesthetic infusion group had lower opioid requirements after surgery. This group also had improved functional recovery 6 weeks after surgery, which was the latest time point at which assessments were made. Another small randomized controlled trial of patients having total knee replacement was reported by Nader and colleagues.27 All patients received epidural anaesthesia, which was maintained until the morning after surgery. The intervention group had a further 24 h infusion of ropivacaine through a femoral nerve catheter, whereas the other group received standard oral opioid analgesia. The patients were not blinded to the treatment they received. Analgesia was better in the femoral nerve infusion group during the period of infusion. Ability to flex the knee was also better in the infusion group, and this was maintained for 1 month. At 6 months after surgery, there were no differences in pain or any functional measure, or indeed, any measure of daily living. Figure 1 shows the results of ability to flex the knee from patients in this study throughout the 12 month study period. This pattern of initial functional gain with improved acute pain management but no long-term functional difference may well prove to be a typical picture.

A similar result was found in a study of longer-term functional outcomes of total knee arthroplasty by Ilfeld and colleagues.18 Again, this was not a comparison between general anaesthesia and regional anaesthesia but a comparison of overnight continuous femoral nerve block with overnight plus three additional days of nerve block. The continuation of the block for 4 days had previously been shown to improve analgesia during the period of the infusion but not after. There was no difference in persisting pain, joint stiffness, or function from 7 days to 12 months after surgery. The authors had previously reported a similar study on patients having total hip replacement.11

**Fig 1** Box plot of the difference in knee-flexion degrees from baseline during the immediate postoperative period and long-term follow-up. D, day; M, month. The horizontal line represents the median value, the boxes are the interquartile range, and the whiskers are the 10th and 90th percentile range. †Significantly greater knee flexion at day 1 (P=0.001), day 2 (P=0.006), and month 1 (P=0.04) in subjects receiving femoral nerve analgesia when compared with the opioid analgesic group. At the 6 and 12 months follow-up, subjects receiving continuous femoral analgesia demonstrated a gain of 5° in knee flexion compared with the opioid analgesic group (P=0.42 and P=0.10, respectively). Reproduced with permission from Wiley.
intervention here was continuation of the lumbar plexus infusion of local anaesthetic for 4 days compared with only 1 day. The 4 day infusion provided better analgesia during the infusion, but long-term follow-up again showed no improvement in functional outcome or long-term pain up to 12 months after surgery.

Wegener and colleagues also were interested in the longer-term follow-up of a total knee arthroplasty trial that had demonstrated improved acute pain relief. This was a follow-up analysis of a trial that initially reported improved postoperative pain by addition of sciatic nerve block to continuous femoral nerve block after total knee arthroplasty. Various functional measures were made at 3 and 12 months after surgery in 89 patients. There was no association between the interventions and functional outcome. The authors concluded that the improved short-term pain improvement with sciatic nerve block did not translate into longer-term functional benefits or reduction in persisting pain.

Atchabahian and colleagues attempted to carry out a systematic review to assess functional outcomes 3, 6, and 12 months after knee, shoulder, or hip replacement surgery with respect to the effect of regional anaesthesia and analgesia. The regional anaesthesia group included all forms of regional anaesthesia. No distinction was made between patients who received regional anaesthesia alone or regional anaesthesia plus general anaesthesia. There were relatively few randomized controlled trials, and the authors resorted to including trials where the investigator undertaking a functional assessment was not blinded. Only six trials involving 350 patients met the criteria for inclusion. As a result of the high degree of heterogeneity for outcome and reporting, only three of the trials could be collated and then only ranges of the high degree of heterogeneity for outcome and reporting.

The authors resorted to including trials where the investigator distinguished between patients who received regional anaesthesia group included all forms of regional anaesthesia. No distinction was made on 9167 patients who had general anaesthesia and 7388 patients who had neuraxial anaesthesia for unilateral knee arthroplasty. There was no significant difference in 30 day mortality. The analyses included multiple regression and separate analysis with propensity score matching. Neuraxial anaesthesia was associated with a lower risk for pneumonia (odds ratio=0.51, 95% CI 0.29–0.90). The composite outcome of all systemic infection risk was also reduced in the neuraxial anaesthesia group (odds ratio=0.77, 95% CI 0.64–0.92).

The American College of Surgeons’ quality improvement programme database has also been used to explore major complications of total hip replacement. Helwani and colleagues looked at the period from 2007 to 2011. They report on nearly 13 000 total hip replacements, of which 5103 were done under regional anaesthesia. The primary outcome was length of hospital stay. There was a significant reduction in length of hospital stay with regional anaesthesia, but the effect size reported was comfortably within the margin of error in measurement of hospital stay. There was a significant reduction in the risks of cardiovascular and respiratory complications in the regional anaesthesia group. Basques and colleagues undertook an analysis of a large retrospective cohort encompassing the years 2010–2012 from the American College of Surgeons’ national surgical quality improvement programme database. In this study, 12 752 patients who received general anaesthesia for total hip arthroplasty were compared with 8184 patients who had spinal anaesthesia. To account for differences in baseline characteristics between the groups, a propensity-adjusted multivariate analysis was used. The analysis did not encompass differences in desired outcome from surgery but focused on adverse events. The incidence of any adverse event was significantly greater in the general anaesthesia group (odds ratio=1.31, 95% CI 1.23–1.41, P<0.001). Interestingly, there were convincing data to demonstrate reduced blood transfusion requirements in spinal vs general anaesthesia (odds ratio=1.34, 95% CI 1.25–1.45, P<0.001). The data also suggest the possibility of a major increased risk of stroke (OR=2.51, 95% CI 1.02–6.2, P=0.046) and cardiac arrest (OR=5.04, 95% CI 1.15–22.07, P=0.032) with general anaesthesia.

Repair of fractured neck of femur

patients having general anaesthesia and 5254 having regional anaesthesia. The primary outcome was in-hospital mortality. Using an adjusted fixed-effects model, the odds ratio for death after regional anaesthesia compared with general anaesthesia was 0.71 (95% CI 0.54–0.93). There was also a significant reduction in the risk of pulmonary complications with regional anaesthesia (odds ratio=0.75, 95% CI 0.64–0.89). A less clear-cut result was found by the same group using New York’s state-wide planning and research cooperative system database of hospital discharges and patient data. As mentioned earlier, a surrogate indicator of type of anaesthesia was used to match 21 514 patients according to their sex, the type of fracture, the surgical procedure, the year of surgery, and the presence or absence of chronic lung disease. There was no difference between these groups in 30 day mortality. Supplementary matched-pair analyses involved within-hospital matches (23 482) and between-hospital matches (31 808) for general anaesthesia vs regional anaesthesia. The within-hospital match showed no effect of anaesthesia type on risk of 30 day mortality, but the between-hospital match found a reduction in risk of 30 day mortality from 5.8% with regional anaesthesia to 5.3% with general anaesthesia (95% CI for the difference in risk −1.0 to 0.0, P<0.03). It should be noted that the general anaesthetic group in the supplementary matches of the study included an unknown number of patients who had received regional anaesthesia in combination with general anaesthesia.

Analysis of a large cohort from the UK found no difference in mortality associated with regional compared with general anaesthesia. This was an analysis of the UK hip fracture national database for 2012. This comparison only included patients who had either spinal anaesthesia or general anaesthesia alone. There were no differences in mortality up to 30 days after surgery. Interestingly, there was no difference in 30 day mortality according to ASA physical status or age between general anaesthesia and spinal anaesthesia groups. Again in the UK, Parker and Griffiths attempted an ambitious prospective randomized controlled trial of general vs regional anaesthesia for hip fracture repair. The result was a small non-blinded randomized controlled trial throughout a period of 5 yr in a single hospital. In that period, 2200 patients were admitted with hip fracture and evaluated for inclusion in the trial. The majority of patients (1878) were excluded for a variety of reasons (for example, chest disease precluding general anaesthesia or heart disease precluding spinal anaesthesia) or did not meet inclusion criteria. Of the 322 patients included and randomly allocated, 164 received general anaesthesia and 158 spinal anaesthesia. The primary outcome was mortality. At 1 yr, 19 of the general anaesthesia group (11.7%) and 32 of the spinal anaesthesia group (20.2%) had died, P=0.05 (Fig. 2). Owing to the range of exclusion criteria, these data are unlikely to be generalizable.

Other trauma

Egol and colleagues reported two retrospective cohort studies from a single centre. The first of these considered 187 patients with distal radial fracture having fixation by plate and screws. Patients who had internal fixation under regional anaesthesia had better acute pain relief and also better functional scores at 3 and 6 months after surgery. The second cohort considered 92 patients who received either interscalene block or general anaesthesia for repair of a proximal humeral fracture. It seems that the method of anaesthesia was decided by the anaesthetist. The principal outcome measure was functional recovery from the fracture and repair. The assessment of recovery was not blinded, and this took place at varying intervals after surgery. However, a clinically important, statistically significant improvement in recovery was reported in the regional anaesthesia group. The authors propose that the block assists the patient in progressing with passive range-of-movement exercises ‘promptly and more vigorously’ after surgery.

Vascular surgery

I have already mentioned the two studies that analysed the same database during the same time period for the influence of the type of anaesthesia on outcome from carotid endarterectomy surgery. In addition to retrieving different numbers of patients, the authors of the two studies drew different conclusions, despite both using propensity score modelling or matching. Schechter and colleagues looked at a total cohort of 20 670 patients having general anaesthesia compared with 4046 patients having regional anaesthesia. A subset of 8050 patients were matched based on propensity scores. In neither analysis was there a significant difference in the primary outcome measures (composite mortality and major complications) between general anaesthesia and regional anaesthesia. Leichtle and colleagues found 22 054 patients having general anaesthesia and 4016 having regional anaesthesia. A propensity score model was used to assess the influence of type of anaesthesia on stroke, myocardial infarction, and death. It was found that a history of myocardial infarction was a significant risk factor for postoperative myocardial infarction, with an adjusted odds ratio of 2.18 (95% CI 1.17–4.04). In a subgroup analysis, myocardial infarction was an even greater risk factor in those patients with preoperative neurological deficit (odds ratio 5.41, 95% CI 1.32–22.16) but not in those without preoperative neurological deficit.

An analysis of a multicentre registry has investigated the role of the type of anaesthesia on the outcome in endovascular aneurysm repair. There were three groups [general anaesthesia (n=785), regional anaesthesia (n=331), and local anaesthesia (n=145)]; there was no difference in perioperative mortality or morbidity. Use of local or regional anaesthesia reduced procedure time, intensive care unit admission, and hospital stay. Interestingly, intensive care unit admission was less frequent for
regional anaesthesia than for local anaesthesia patients. There were differences between countries in the types of anaesthesia used and differences in ASA status between types of anaesthetic; patients with higher ASA grade were more likely to receive general anaesthesia.

The POISE trial was a randomized controlled trial of the effect of perioperative β-blocker therapy on cardiovascular outcomes. Although the POISE trial included patients other than those having vascular surgery, many did, and so I have included the secondary analysis of this trial here. Considering all forms of neuraxial block, the authors concluded that there was an increased incidence of a composite primary outcome of cardiovascular death, non-fatal myocardial infarction, or non-fatal cardiac arrest within 30 days (odds ratio=1.24, 95% CI 1.02–1.49). Patients having epidural combined with general anaesthesia had a worse outcome than those having general anaesthesia alone (odds ratio=2.95, 95% CI 2.0–4.35).

**Colectomy**

There has been much recent interest in the role of regional anaesthesia in enhanced recovery programmes, including those for colectomy patients. This is, however, the subject of a separate review in this issue. Poeran and colleagues looked specifically at the impact of adding neuraxial anaesthesia to general anaesthesia on major complications of colectomy. This study analysed data from almost 100,000 patients using a multisite contributor patient database in the USA. The comparison was between patients receiving general anaesthesia alone or with neuraxial anaesthesia. However, slightly fewer than 6000 patients were in the neuraxial and general anaesthesia group compared with more than 92,000 in the general anaesthesia group. Multilevel regression analysis was used to limit the influence of confounders. There was no difference in the composite outcome measure of the incidence of all complications. The incidence of stroke, thromboembolic complications, and cerebrovascular events was reduced in the combined neuraxial and general anaesthesia group. However, the combined group was associated with a significantly increased incidence of acute myocardial infarction, postoperative urinary tract infection, postoperative ileus, and admission to the intensive care unit. The authors concluded that an approach of ‘one size fits all’ was probably not appropriate, and choice of anaesthetic should be targeted to individual patients.

**Conclusions**

There continues to be considerable effort expended in looking for a significant impact of regional anaesthesia on surgical outcomes. This is not surprising given the number of enthusiasts for regional anaesthesia, myself included. Nonetheless, a clear and consistent benefit of regional anaesthesia on long-term outcome remains elusive. The data reviewed here seem to suggest that short-term improvements in postoperative acute pain management do not translate into long-term functional gain in orthopaedic surgery, but it should be remembered that the trials to date are small; clinically important differences could still exist. With regard to the impact of type of anaesthesia on complications of surgery, this review and previous commentaries suggest that at least in some circumstances general anaesthesia is associated with a reduced incidence of some complications, or conversely, the risk of complications of regional anaesthesia exceeds that of the risks of general anaesthesia. Poeran and colleagues very reasonably imply that patient factors may well interact with the type of anaesthetic in determining outcome. These are indeed likely to be important confounders, but we should not dismiss the possibility that the anaesthetist’s ability to manage regional anaesthesia as well as they manage general anaesthesia could also be an important confounder.

**Author’s contribution**

P.M.H. conceived, wrote, and is solely responsible for the content of this review.

**Declaration of interest**

P.M.H. has the use of ultrasound equipment loaned by SonoSite Inc. P.M.H. is an Editorial Board Member and Trustee of the British Journal of Anaesthesia.

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Handling editor: H. C. Hemmings