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Regional anesthesia at home

Gloria S. Cheng, Lynna P. Choy, and Brian M. Ilfeld

Department of Anesthesiology, University of California San Diego, San Diego, California, USA

Abstract

Purpose of review—To review the recently published peer-reviewed literature involving regional anesthesia and analgesia in patients at home.

Recent findings—The potential benefits and risks of regional anesthesia and analgesia at home are pertinent queries, and increased data regarding these topics are rapidly becoming available. Of particular interest is the use of continuous peripheral nerve blocks at home and their potential effect upon hospitalization duration and recovery profile.

Summary—Advantages of regional techniques include site-specific anesthesia and decreased postoperative opioid use. For shoulder surgeries, the interscalene block provides effective analgesia with minimal complications, whereas the impact and risks of intraarticular injections remain unclear. Perineural catheters are an analgesic option that offer improved pain relief among other benefits. They are now being used at home in both adult and pediatric populations.

Keywords

ambulatory continuous peripheral nerve blocks; ambulatory patient-controlled regional analgesia; ambulatory perineural local anesthetic infusion; ambulatory surgery; regional analgesia at home

Introduction

As regional anesthesia enjoys a resurgence in popularity, a critical look at the available published data regarding these techniques is imperative. Recently, multiple studies evaluating regional anesthesia and analgesia in the outpatient setting have become available to further evaluate its safety, efficacy, and application. The findings suggest that regional anesthesia in the ambulatory setting offers many benefits to patients with what appears to be an acceptable risk–benefit profile. However, there are many unanswered questions remaining that require additional prospective research to answer.

Single-injection peripheral nerve blocks

A number of recent publications provide information on single-injection peripheral nerve blocks providing analgesia at home.

Intravenous regional anesthesia

When used in intravenous regional anesthesia (IVRA) (i.e. ‘Bier block’), ropivacaine provides a more prolonged sensory blockade than lidocaine. Although many question whether the risk of ropivacaine cardiac toxicity is outweighed by prolonged postoperative analgesia, investigators have recently compared ropivacaine with prilocaine for intravenous regional

anesthesia in ambulatory patients [1]. Used extensively in Europe, prilocaine is a local anesthetic with a profile similar to lidocaine. Unlike the previous studies with lidocaine, the recent randomized, double-masked study provided evidence that the use of ropivacaine resulted in slower onset of analgesia and, except for a short, clinically insignificant extension of sensory block in the median nerve, no increase in analgesia duration when compared with prilocaine [1]. Though patients in the prilocaine group used oral analgesics slightly earlier than those in the ropivacaine group, the difference did not reach statistical significance. Local anesthetic plasma concentrations were also higher with ropivacaine than with prilocaine. Although there were no signs or symptoms of central nervous system or cardiac toxicity, the sample size ($n=60$) was too small to draw conclusions regarding relative risks of rare complications such as cardiac toxicity. Owing to the significant risk of catastrophic cardiac toxicity in the case of inadvertent early tourniquet release/leak, these new data do not suggest that ropivacaine should replace time-tested local anesthetics such as lidocaine and prilocaine for intravenous regional anesthesia.

Paravertebral blocks

Single-injection paravertebral blocks were recently described for ureteroscopic laser lithotripsy and extracorporeal shock wave lithotripsy (ESWL) [2]. The blocks were placed prior to surgery and no opioids were needed during the procedure, in the recovery room, or during the first 24 h postoperatively. The use of paravertebral blocks for outpatient urologic procedures offers the possibility of site-specific postoperative pain relief and greatly decreased systemic opioid requirements.

Interscalene brachial plexus blocks

For arthroscopic shoulder surgery, an interscalene block provides multiple advantages over general anesthesia, such as improved postoperative analgesia, decreased postoperative nausea and vomiting, and avoidance of intraoperative intubation [3,4]. However, concerns regarding its complications and success rate have somewhat limited its use. Two studies evaluated the safety and efficacy of the interscalene block for outpatient shoulder surgeries [5,6]. A retrospective chart review of 295 patients revealed a 96% success rate, a 1% rate of minor complications (i.e. transient sensory paresthesias), and no resultant major complications [5]. Nonsurgical operating room times were decreased when an interscalene block was used in lieu of general anesthesia. An understanding of the block and its anticipated effects by patients and surgeons – as well as a process of continual technique refinement by the anesthesiologists – contributed to the resultant safety and efficacy of the interscalene single-injection anesthetic. In a separate study, a prospective evaluation of 133 patients found a 98% success rate with one (0.7%) major complication (one grand mal seizure), two (1.4%) transient postoperative neurapraxias, and 37 (28%) minor complications (e.g. neck pain and bruising) [6]. Preoperative and postoperative neurologic assessments were performed, but no correlations with subjective findings were found. These two studies add evidence in support of findings from previous larger, prospective clinical studies that found the risk–benefit ratio of interscalene blocks/catheters to be favorable.

An alternative analgesic technique for shoulder surgery involves placing local anesthetic in the subacromial and/or intraarticular spaces. One recent investigation compared a single-injection interscalene block with patient-controlled subacromial local anesthetic infusion for postoperative pain management after arthroscopic shoulder study [7]. No statistically significant differences of daytime pain and quality-of-life scores were found between the two treatments, although there was a trend for patients with the subacromial infusion to report fewer nighttime awakenings, more physical activity, and lower oral medication requirements than patients receiving the block. Unfortunately, detailed descriptions of the interventions were not described making it impossible to evaluate the presented data and draw definitive conclusions.

Approval by a local Institutional Review Board was not mentioned, and one of the primary authors was an employee of the company that makes the infusion device. Because of these multiple significant methodological flaws, this new article does not provide quality data and should not be used to plan clinical treatment.

A far-superior randomized, double-masked investigation evaluated the efficacy of patient-controlled intraarticular analgesia following Bankart shoulder surgery [8•]. Fifty-one patients were randomized into one of two infusions: ropivacaine/morphine/ketorolac or isotonic saline. Those receiving an isotonic saline infusion were also randomized to receive a single dose of either intravenous ketorolac or isotonic saline. Patients receiving the active medication experienced slightly decreased pain during the first two postoperative hours, and a high median satisfaction score. However, there were multiple variables at play and the study design makes it difficult to elucidate which (or if all) of them contributed to the outcome. For example, the study does not address whether intraarticular ketorolac and morphine is advantageous when compared with intraarticular local anesthetic, nor can it determine whether intraarticular single-injection or patient-controlled intraarticular anesthesia contributes more greatly to postoperative analgesia. It is not surprising (nor is it novel information) that infusing analgesics directly into a surgical wound provides limited – many would argue minor – benefits, and this new article adds relatively little to the debate of whether the limited benefits of this technique outweigh the cost and potential risks (e.g. infection).

Continuous peripheral nerve blocks

As the use of continuous peripheral nerve blocks (CPNBs) increases, so does interest in their use in the outpatient setting [9].

Ambulatory continuous peripheral nerve blocks

A retrospective review of patients discharged home with a perineural catheter placed under ultrasound visualization examined catheter-related complications and necessary interventions [10]. Patients received an interscalene, popliteal sciatic, or femoral catheter, depending on the surgical procedure. Two of 620 patients (0.3%) had complications: one related to a compression injury at the head of the fibula and the other diagnosed with complex regional pain syndrome. Interventions were required for 26 of 620 patients (4.2%), most commonly requiring a bolus of local anesthetic through the catheter. In a system with good patient education and access to follow-up care, continuous peripheral catheters can be successfully used in the outpatient setting with minimal complications and need for medical intervention.

Medically related quality-of-life

There are three basic ways of delivering an infusate: a basal-only infusion, patient-controlled bolus doses, or a combination of the two. A multicenter, randomized trial compared the quality of functional outcome at home in patients who received either patient-controlled intravenous morphine, a fixed basal infusion of perineural local anesthetic, or a fixed basal infusion combined with patient-controlled bolus doses of perineural local anesthetic for 72 h postoperatively [11]. On the second and third days, more patients in the basal-bolus perineural infusion group reported the ability to perform daily activity without assistance than in the other two groups as measured with an unvalidated quality-of-life instrument. Not surprisingly, patients with the perineural catheter reported fewer side effects (e.g. nausea/vomiting, dizziness, and sleep disturbances) than the patients who received intravenous morphine. Unfortunately, this study was ended early because one participant receiving patient-controlled intravenous morphine via the non-electronic, elastomeric infusion device experienced life-threatening respiratory depression. The investigators did not comment on whether using elastomeric devices to administer intravenous opioid is considered standard-of-care at their

institution, or whether participants were informed that by participating in this study they would be exposed to a significant risk that they otherwise would not be exposed to. Regardless, administration of intravenous opioid with an elastomeric portable infusion pump to patients at home cannot be recommended on both theoretical grounds, and after the experience of the investigators of this study.

Femoral

A new randomized clinical trial examined the effect of continuous femoral nerve blocks following anterior cruciate ligament reconstruction [12]. Patients received a femoral perineural catheter infused with an isotonic saline bolus with isotonic saline infusion; levobupivacaine bolus with isotonic saline infusion; or levobupivacaine bolus with levobupivacaine infusion. Compared with the placebo infusion groups, pain scores were lower in patients who had received a levobupivacaine bolus and infusion. Although the randomized and masked nature of this study provides high-quality data, the relatively long duration of the levobupivacaine single-injection femoral blocks (over 24 h in some patients) and relatively short duration of perineural infusion (approximately 48 h) limits the usefulness of these data. However, this study does add to the existing data demonstrating that a perineural local anesthetic infusion decreases pain and supplemental opioid requirements.

Several randomized, double-masked, placebo-controlled studies have demonstrated an association between CPNB and decreased nausea and vomiting and sleep disturbances. In contrast, a recently published retrospective analysis of prospectively collected data from 233 patients with CPNBs found a lack of association. The investigators concluded that the addition of a femoral CPNB to a multimodal anesthetic/antiemetic technique for anterior cruciate ligament repair did not improve outcomes of nausea, vomiting, and sleep quality [13]. A second retrospective study involving the same cohort of patients was reported on rebound pain scores [14]. Unfortunately, patients were instructed to take sustained-release oxycodone on a regular basis regardless of pain scores until postoperative day 4 [15]. This mandatory use of opioid analgesics in all patients could account for the lack of difference in nausea, vomiting, and sleep disturbance between patients who received a continuous infusion of local anesthetic and those who received isotonic saline (placebo). In addition, the required use of sustained-release oxycodone may have masked sleep disturbance that would otherwise occur in patients without a levobupivacaine femoral nerve block, resulting in a lack of association between femoral nerve block and sleep disturbance. Similarly, the attenuation of pain scores by required opioid dosing probably minimized the rebound pain scores reported in the data. The mandatory dosing of sustained-release opioids in these studies confounds their usefulness, as data from previous investigations provide very strong evidence that following moderate-to-severely painful surgery, adding a CPNB to a multimodal analgesic regimen in the ambulatory environment – with opioids used as needed – is associated with decreased opioid requirements, opioid-related side effects, sleep disturbances, and postinfusion ‘rebound’ pain.

Two potential complications of femoral CPNB were reported in recent publications. In the first of these reports, 13 of 233 patients (5.6%) with a femoral perineural catheter in place for anterior cruciate ligament repair reported ‘tenderness, bleeding, or other skin problems’ [16]. The dressing for the catheters involved 5 cm wide Hy-tape placed around the margins of bioocclusive dressings on top of skin prepped with benzoin or mastisol. The reactions were surmised to be a result of either an adverse reaction to benzoin (which has a 13% incidence of allergic skin reactions) or the airtight seal caused by the placement of Hy-tape. Since converting the dressing technique to one using mastisol and an absorptive dressing, the skin reactions have ceased. In the second report, four of 233 patients (1.7%) with a femoral CPNB for anterior cruciate ligament repair reported falling [17]. Each of the four received a bolus of levobupivacaine (0.25%) before the nerve catheter was placed; the infusion device in three of

the four contained levobupivacaine (0.25%), whereas the fourth was filled with isotonic saline (placebo). Combined with other reports of falls by patients with a femoral single-injection or CPNB, these new data suggest that the incidence of falls related to lower extremity nerve blocks is underreported and the exact incidence remains unknown.

Early home discharge

In the United States, total shoulder and elbow arthroplasty results in hospitalization duration of 1–4 days, whereas total knee and hip arthroplasty results in an average hospitalization duration of 4 days. Four recent studies investigated the possibility of shortening hospitalization with the use of ambulatory CPNB following joint arthroplasty [18–22]. Following shoulder and elbow arthroplasty, a series ($n=6$) of healthy, motivated patients were discharged home directly from the recovery room with continuous interscalene or infraclavicular perineural ropivacaine infusions, respectively, and oral analgesics for breakthrough pain [21,22]. All patients continued their infusion for 4–6 days, and pain scores averaged between 0 and 2 on a 10-point scale (0 = no pain at all). There were no infusion-related complications in this small series of patients.

In two related studies, a series ($n=12$) of patients were discharged home the day after primary, tricompartment knee and total hip arthroplasty with continuous femoral or psoas compartment perineural ropivacaine infusions, respectively, and oral analgesics for breakthrough pain [19, 20]. These patients continued their infusion for 4 days, and pain scores averaged between 0 and 3 on a 10-point scale. The patients also experienced no infusion-related complications.

A randomized, triple-masked, placebo-controlled investigation investigated differences between an overnight hospital-based and 4-day ambulatory interscalene CPNB following shoulder arthroplasty [18]. Patients receiving a 4-day ropivacaine infusion ($n=16$) attained three major discharge criteria in a median (10–90th percentiles) of 21 (16–41) h compared with 51 (37–90) h for those receiving an overnight ropivacaine infusion ($n=13$, $P<0.001$). Unlike patients receiving the 4 days of infusion, patients receiving only the overnight ropivacaine infusion often required intravenous morphine, yet still experienced a higher degree of pain and tolerated less external rotation. This study provides high-quality data suggesting that an ambulatory interscalene CPNB considerably decreases the time until readiness for discharge following shoulder arthroplasty, primarily by providing potent analgesia that permits greater passive shoulder movement and the avoidance of intravenous opioids.

These five studies demonstrate the feasibility of converting joint arthroplasty into outpatient or overnight-stay procedures using an ambulatory CPNB as part of a multimodal analgesic regimen provided at home. Although this evidence demonstrates that hospitalization may be avoided or shortened in some cases, it does not define the appropriate subset of patients and incidence of complications associated with this practice. Caution is warranted because, following knee and hip arthroplasty, the median times to myocardial infarction and pulmonary embolism are 1 and 4 days, respectively. Additional data are required to replicate these results in a controlled trial, define the appropriate subset of patients, and assess the incidence of complications associated with this practice prior to its mainstream use.

Continuous peripheral nerve blocks in children

Not surprisingly, as the use of continuous peripheral nerve blocks in adults increases, so does interest in their use in children [23]. An audit of the continuous peripheral nerve blockade program instituted at a children's hospital reviewed the medical records of patients who received CPNB for postoperative pain over a 41-month period [24]. The overall failure rate was 15%, most often due to premature dislodgement. The overall incidence of nausea and vomiting was 14%, similar to results in adults. Of the six (2.8%) reported sensory

complications, numbness in three patients resolved spontaneously [24]. The other three cases were considered to be the result of surgical injury. Other complications included an episode of superficial cellulitis that resolved with oral antibiotics, difficulty removing a catheter that was successfully withdrawn with gentle pressure in the pain clinic, and tinnitus that disappeared after the removal of the catheter. Of the 226 peripheral nerve catheters placed in 217 patients, nearly half (108 patients) were sent home with their catheters in place; 39 (18%) of these patients were discharged on the day of surgery. Only one patient returned to the hospital for inadequate pain control. In patients discharged home with a catheter, all but one catheter was removed successfully by caretakers at home. One patient with an infraclavicular catheter returned to the clinic after resistance was found during removal and the catheter was removed without incident by health-care providers.

In an observational study, 47 children between 3 and 15 years of age were discharged home with a peripheral nerve catheter following elective ankle or foot surgery [25]. The median duration of infusion at home was 2.8 (range 2–4) days, and the perineural catheters were in place for a median total duration of 4 (range 3–5) days. CPNB appeared to provide effective analgesia, as 43% of the children did not require any oral analgesics during infusion. Patient and family overall satisfaction was excellent in 44 patients (93.6%) and good in the remaining three. Proper education of children and their families combined with continuously available contact with medical staff contributed to the successful nature of this prospective study involving the home use of continuous peripheral nerve blocks in children. These two recent reports suggest that ambulatory CPNB in pediatric populations is both viable and potentially valuable.

Financial implications

One recent retrospective study examined upper extremity cases performed in an outpatient surgery center with either peripheral nerve blocks or general anesthesia [26]. There was no statistically significant difference in anesthesia preparation time, which the authors attributed to frequent use of regional techniques. Average recovery room time was shorter in the peripheral nerve block group. Seventy-six percent of the patients who received peripheral nerve blocks were fast-tracked to phase 2 recovery versus 1.7% of patients from the general anesthesia group. Also, there were no unplanned admissions from the peripheral nerve block (PNB) group, but eight from the general anesthesia group. Perioperative cost was $\$3656 \pm 1904$ per patient for the PNB group compared with $\$4780 \pm 2721$ per patient for the general anesthesia group. Although this study provides evidence that regional anesthesia may decrease perioperative cost, its retrospective, unmasked design are significant limitations, and therefore these data are of limited use compared with previously published randomized, controlled trials.

A recent review article included published studies involving cost drivers in anesthesia [27]. The concern of potentially longer induction times leading to increased operating room time usage associated with regional anesthesia is traditionally used as an argument against its use in outpatient surgery. However, Schuster and Standl [27] describe papers that detail the use of block rooms to reduce this time to improve odds ratio (OR) efficacy. In the block room scenario, there is an anesthesiologist available who can place the block ahead of time. This blocked patient can then enter the operating room as soon as a room is available. Staffing physicians to cover the block room is also a cost that must be taken into consideration. The authors of this review article concluded that regional anesthesia techniques can decrease cost in the ambulatory setting because of reduced postoperative side effects and earlier home readiness of the patients.

In addition, CPNB may allow shorter hospitalization duration, potentially decreasing perioperative cost. A recent retrospective study involving patients undergoing tricompart

knee arthroplasty quantified the hospitalization cost for 10 patients receiving ambulatory femoral CPNB for 100 h versus a matched cohort of 10 patients who received CPNB only during hospitalization [28]. Nine patients with ambulatory CPNB (cases) were discharged home on postoperative day (POD) 1, and one on POD 4. Of the controls, three were discharged home on POD 3, six on POD 4, and one on POD 5. The median (range) cost of hospitalization (excluding implant and professional fees) was \$5292 (4326–7929) for ambulatory cases compared with \$7974 (6931–9979) for inpatient controls (difference = \$2682, 34% decrease, $P < 0.001$). The total charges for hospitalization, the implant, and professional fees were \$33 646 (31 816–38 468) for cases compared with \$39 100 (36 096–44 098) for controls (difference = \$5454, 14% decrease, $P < 0.001$). The authors noted that a readmission rate of just 10% could potentially negate these cost savings.

Conclusion

Single-injection regional techniques provide improved postsurgical analgesia and minimize opioid requirements. Consequently, their use for an increasing scope of outpatient surgeries is not surprising. Perineural catheters are being used at home by adults and children with a favorable risk–benefit ratio and high patient satisfaction. However, there are many unanswered questions remaining that require additional prospective research to answer.

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References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
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Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 526).

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