Continuous Peripheral Nerve Blocks: Analgesia Takes a Step Forward

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Since the arrival of Y2K, over 200 articles have been published describing the use of continuous peripheral nerve blocks (CPNBs). These articles have ranged from basic descriptions of the techniques to complications to a recent meta-analysis of the techniques. There are studies on the merits of one type of catheter placement versus another (1–3). There are reports that analyze the optimal local anesthetic and additives to use as infusate and mode of infusion (4–7). There are reports on the benefits of these techniques when compared with more traditional analgesic techniques (8–10). I think it is fair to say that CPNBs have arrived as an accepted and expected mode of analgesia and that analgesia has taken a step forward with the wide application of the techniques. There are several elements that have intersected to make these techniques a part of mainstream analgesic offerings.

Surgeons, particularly orthopaedic surgeons have become vocal advocates for the use of continuous peripheral nerve blocks. They have come to appreciate the important role of analgesia in rehabilitation, return to daily activities, and patient satisfaction following surgery. A meta-analysis of CPNB analgesia when compared with opioid analgesia found that regardless of catheter location, CPNB provided superior postoperative analgesia and fewer opioid related side effects (11). The report examined 19 randomized clinical trials involving 603 patients of whom 563 were orthopaedic patients with lower extremity catheters. In addition, CPNB analgesia has made the ever increasing magnitude of operations performed on an outpatient basis in the United States of America feasible. The degree of analgesia provided by CPNB techniques simply cannot be achieved by oral analgesics, the main stay of ambulatory surgery analgesia, even in the setting of multimodal therapy (12).

For anesthesiologists, the technical advances in equipment and applications, including ultrasound, have led to a wider interest in the use of regional anesthesia and CPNB in particular. The initial impetus for wider application of CPNB occurred in 1997 when the FDA issued a public health advisory and black box warning concerning the risk of spinal hematoma in patients receiving low molecular heparin and epidural anesthesia or analgesia (13). This change in the risk-to-benefit ratio for epidural analgesia sparked considerable interest in the use of CPNBs for pain control after major orthopaedic and vascular surgery. The introduction of ultrasound as an adjunct to the nerve stimulating techniques codified in the 1990s has again broadened the appeal of peripheral nerve block as an anesthetic or analgesic technique (14). The visual feedback of watching the local anesthetic spread has taken some of the mystery out of the application of these techniques for the general anesthesiologist (15).

LOWER EXTREMITY APPLICATIONS OF CPNB

The most common application of CPNB has been for the lumbar plexus to provide analgesia following total knee arthroplasty (TKA) and total hip arthroplasty (THA) (16–21). The demonstrated benefits of this technique include reducing intraoperative blood loss (22), decreasing postoperative pain, improving patient satisfaction, and improving rehabilitation as measured by degree of knee flexion when compared with IV opioid administration (8,9). When compared with epidural analgesia, CPNB offers a similar degree of analgesia with unilateral analgesia, less bladder instrumentation, less hypotension, and has fewer technical difficulties (23). Continuous lumbar plexus catheters have also been used for analgesia following total hip arthroplasty (THA), open reduction and internal fixation (ORIF) of acetabular fractures, and anterior cruciate ligament reconstruction (24–26).

Does CPNB provide a distinct advantage to patients enrolled in highly sophisticated clinical paths that combine multimodal analgesia with the use of single injection nerve blocks? In a study comparing CPNB versus single injection femoral nerve block for analgesia following TKA, Salinas et al. could show reduced narcotic consumption and pain scores in the patients receiving CPNB (27). However, they could show no difference in hospital length of stay (3.8 vs 3.9 days) or long-term functional outcome. Recently, Ilfeld et al. reported on the use of continuous femoral nerve blocks for one night stay TKA (28). In a highly selected cohort of ASA I–II patients, nine out of 10 patients were discharged home on the first day after TKA with a patient controlled basal plus optional bolus ropivacaine infusion in the setting of multimodal analgesia (routine oxycontin, acetaminophen, and oxycodone for breakthrough pain). These patients underwent intensive physical therapy that required education of both the physical therapist and the patient. These patients reported a very high level of satisfaction with their analgesia. This study highlights several key points regarding CPNB. The first is that with careful application and in the setting of multimodal analgesic therapy, this technique can offer profound analgesia in an out of hospital setting. The second point to note is the intensive education and coordination of care that must be present for this technique to be applied successfully.

Another common application for CPNB analgesia is continuous sciatic nerve block for foot and ankle surgery. Few complications and a 97.5% success rate (as defined by a VAS score of 3 or less in the postoperative period) were reported by Borgeat et al. in 1001 patients undergoing continuous popliteal block for foot and ankle surgery (29). None of the patients who had surgery only in the territory of the sciatic nerve required rescue IV morphine for breakthrough pain. Those patients in whom the surgical incision extended into the territory of the saphenous nerve did require low levels of rescue morphine. This emphasizes the site specific analgesia provided by these techniques. The opioid sparing effect of CPNB is very specific. For procedures that cross multiple nerve territories other means of analgesia must be employed. The impressive degree of analgesia provided by popliteal catheters can be translated into quality of life improvement in the postoperative period. In a multicenter randomized trial comparing continuous popliteal block with a basal infusion group, basal with optional bolus infusion group, and IV morphine group for analgesia following foot surgery, patient's ability to walk for 10 min significantly increased in the three groups at 12.5, 20.5, and 40.5 h, respectively (12).

The use of a stimulating versus nonstimulating catheter has been hotly debated in the regional anesthesia world. Most providers would agree that non-stimulating catheters are easier to place while stimulating catheters decrease local anesthetic consumption (1–3). Small differences in local anesthetic consumption and in supplemental narcotic requirements can be demonstrated, but a clinical difference in pain scores or opioid related side effects has not been shown when comparing stimulating versus non-stimulating catheters (1–3). In the study of Borgeat et al., 97.5% success rate was achieved with the use of nonstimulating catheters. The technique used by these investigators was to advance the catheter only two centimeters past the stimulating needle tip (28). This agrees with the smaller study of Gartner et al. who reported a 100% success rate of parasacral catheters when the nonstimulating catheters were threaded only 2 cm past the tip of the stimulating needle (30).

Because many of the patients receiving continuous lower extremity blocks are also receiving concomitant thromboembolic prophylaxis, the issue of bleeding complications should be addressed. The actual risk of these complications is not well defined although there are case reports in the literature of significant hematoma formation both during insertion and removal of CPNB catheters (31–33). For this reason, the American Society of Regional Anesthesia and Pain Medicine recommends conservative management of these catheters in patients receiving setting of thromboembolic prophylaxis (34). However, it must be mentioned that even in these case reports none of the patients suffered permanent injury as a consequence of the bleeding complication. Thus the risk of bleeding complications should be weighed against the superior analgesia these techniques offer.

UPPER EXTREMITY APPLICATIONS OF CPNB

Upper extremity CPNB, particularly high brachial plexus block, either interscalene (ISB) or posterior cervical approach, have quickly become the gold standard for analgesia following shoulder surgery. Borgeat et al. reported the first large series of patients using continuous ISB for analgesia following major shoulder surgery (35). When compared with IV opioid analgesia they found that continuous ISB led to higher patient satisfaction, lower additional narcotic use, and improved rehabilitation. These investigators felt the major difference between the groups was the ability to reinforce the block with patient controlled boluses before physical therapy. Ilfeld and colleagues have also demonstrated improved quality of the rehabilitation in terms of total degrees of shoulder movement and the time to reach these milestones in patients receiving continuous ISB therapy compared to patients receiving IV opioid therapy (36,37). Continuous brachial plexus analgesia has clearly made an impact on the magnitude of procedures that can be contemplated as an outpatient. Comparing single injection ISB with continuous ISB in a double-blind randomized study, Ilfeld et al. were able to demonstrate a difference in pain scores, narcotic consumption, and sleep quality for patients undergoing shoulder surgery including capsular release, rotator cuff repair, and instability procedures (38).

Continuous infraclavicular blocks have been used for painful surgeries including total elbow replacement, ORIF of radius and ulna, and complex elbow reconstruction (39,40). The theme of decreased VAS pain ratings, decreased opioid use, and decreased opioid related side effects can be demonstrated in these patients when compared with patients that receive placebo infusions.

CPNB of the upper extremity can improve not only pain scores and rehabilitation related to participation in physical therapy, but has proved extremely valuable as a mechanism for improving vascular flow in patients with vasospastic diseases, crush injuries, and digital reimplantation surgeries (41–43). The most common approach in these reports has been continuous axillary block or surgically placed catheters lower in the forearm. Taras and Behrman reported a 93% survival rate for reimplanted digits when a continuous infusion of local anesthetic through a forearm catheter was used in a setting of multimodal therapy (41).

CPNB of the upper extremity has also been used to provide analgesia following upper extremity amputation (44,45). Schley et al. used continuous axillary blocks to provide analgesia for 7 days following traumatic amputation of the upper extremity (45). At 4 wk, patients who were also treated with an NMDA antagonist had lower intensities of phantom limb pain than a placebo control group, but all patients had relatively low intensity phantom limb pain at 12-mo follow-up. This effect was not seen when a 72-h infusion of the NMDA antagonist, ketamine, was used in lower extremity amputations in patients receiving general anesthesia (46).

CONTINUOUS PARAVERTEBRAL BLOCKS

Continuous thoracic paravertebral catheters (PVB) have been used for analgesia for breast surgery, multiple rib fractures, minimally invasive coronary artery bypass surgery, and thoracotomy (47–50). In a meta-analysis comparing thoracic epidural (TEA) with continuous PVB for analgesia following thoracotomy found that pain scores were low and similar between the two techniques (50). However, when side effects, including hypotension, pulmonary complications, and incidence of those related to opioids were reviewed, PVB improved outcome compared to TEA. In addition, fewer technical failures were found in the PVB patients. All the limitations of meta-analysis must be considered when reviewing these results, especially the lack of blinding, and small trial sizes (total 520 patients). However, these findings are consistent with comparisons of CPNB to epidural analgesia in other anatomic locations and show great promise for further investigation.

CONTINUOUS WOUND INFUSIONS FOR ANALGESIA

Direct application of a catheter into a wound bed has been used for analgesia following an almost infinite variety of procedures (51). The universal embrace of this technique comes from the theoretically obvious blockade of the source of pain, the simplicity of insertion under direct vision, and the lack of complications attributable to the technique. A recent meta-analysis of randomized trials has been conducted to examine the efficacy of this modality (51,52). This report concluded that wound catheters consistently demonstrated analgesic efficacy in terms of pain scores, opioid consumption, and opioid-induced side effects. Importantly the rate of wound infection was low and similar between active and placebo catheter groups.

Few studies have directly compared CPNB with wound infusions. Klein et al. compared continuous ISB analgesia to intraarticular shoulder infusions for analgesia following rotator cuff repair (53). They reported pain scores consistently lower in the ISB group although the difference was not statically significant. In addition, they reported technical difficulty with the intraarticular group in terms of anesthetic leakage and difficulty with catheter removal.

CONCLUSION

Continuous infusions of local anesthetics either at the site of a peripheral nerve or plexus of nerves or directly into the wound bed provides analgesia and reduces narcotic consumption after nearly every procedure reported. The holy grail of analgesia is to skip the infusion issues and move to a timed release formulation of local anesthetics. Yet the step forward in analgesia as provided by continuous infusion therapy should not be overlooked. Valuable information regarding the length of analgesia therapy, the chronobiology of that therapy, and the ideal instillation sites is being provided by the current techniques. These techniques are also available today. Surveys of hospitalized surgical patients still report up to 80% of patients report pain after surgery (54). Of these patients 86% report their pain as moderate to severe in the postoperative period. The techniques reviewed in this paper can and should make a difference in our patients today. The time is now for anesthesiologist to carefully examine the evidence and pursue advanced analgesia for our patients.

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