



PERIPHERAL NERVE BLOCKS: AN ALTERNATIVE TO OPIOIDS IN POST-OPERATIVE PAIN: - A META ANALYSIS STUDY.

Anaesthesiology

Dr. Kanika S.R, Dept. Of Anesthesia, PGIMS, Rohtak.

Dr. Karan Siwach* S.R, Deptt. Of Orthopaedics, PGIMS, Rohtak. *Corresponding Author

Dr. Mayank Dutta Post Graduate, Deptt. Of Orthopaedics, MAMC Agroha.

Dr. Aman Siwach House surgeon, PGIMS, Rohtak.

ABSTRACT

Peripheral nerve blocks (PNBs) are increasingly used as a method of multimodal analgesia and can be administered as a single injection (sPNB) or continuous infusion via a perineural catheter (cPNB). Meta-analyses of randomized controlled trials have shown superior pain control and reductions in opioid consumption in patients receiving PNB compared with those receiving intravenous opioids in a variety of upper and lower extremity surgical procedures. Risks of PNB, regardless of technique or block location, include vascular puncture and bleeding, nerve damage, and local anesthetic systemic toxicity. Site-specific complications include quadriceps weakness in patients receiving femoral nerve block, and pleural puncture or neuraxial blockade in patients receiving interscalene block. The major limitation of sPNB is the short (12-24 hours) duration of action. cPNB may be complicated by catheter obstruction, migration, and leakage of local anesthetic as well as accidental removal of catheters. The ideal PNB technique would have a duration of action that is sufficiently long to address the most intense period of postsurgical pain; should be associated with minimal risk of infection, neurologic complications, bleeding, and local anesthetic systemic toxicity; and should be easy to perform, convenient for patients, and easy to manage in the postoperative period.

KEYWORDS

post-operative pain, peripheral nerve blocks.

INTRODUCTION

Multimodal analgesia refers to the use of combinations of analgesics acting via different mechanisms and thus taking advantage of additive or synergistic activity while minimizing adverse events with larger doses of a single analgesic [1]. The benefits of PNBs are numerous and include improvement in clinical, economic, and humanistic outcomes (Table 1). PNBs have been associated with improvement in postoperative pain control and reduction in the use of opioids in a variety of surgical procedures [2-7]. Avoidance of opioids minimizes the risk of adverse events associated with them [8,9]. Other benefits of PNBs include reduction in hospital resource utilization [10,11], improved postoperative recovery [10,12,13], and improvement in patient satisfaction [2]. Given the many benefits of PNBs in practice, it is not surprising that their use has expanded over the last several decades. PNBs are now a common component of analgesia for both upper extremity (eg, brachial plexus block using interscalene, supra- or infraclavicular, and axillary nerve approaches) [14] and lower extremity (eg, lumbar plexus, femoral, sciatic, and popliteal sciatic blocks, among others) procedures [15]. One recent study showed that the use of femoral nerve block (FNB, both cPNB and sPNB) after total knee arthroplasty (TKA) among Medicare patients increased dramatically between 2008 and 2009 [16]. The objective of this article is to review the recent literature on sPNB and cPNB as a component of multimodal postoperative analgesia, highlighting benefits, risks, and opportunities for optimizing patient care. A search of the literature was performed using PubMed, including citations published up to March 2017. From the search results and the references cited in articles identified in the search, we selected articles most relevant to our objective. The assessment of efficacy focused on systematic reviews and meta analyses comparing sPNB and cPNB to opioid-based analgesia.

TABLE 1:-

BENEFITS OF PNB AS A COMPONENT OF MULTIMODAL POSTOPERATIVE ANALGESIA REGIMEN	
1.	Improvement in postoperative pain control and reduction in the use of opioids [2-7]
2.	Reduction in hospital length of stay [10,11]
3.	Prevention of hospital readmissions [16]
4.	Reduction in postoperative nausea and vomiting [2]
5.	Faster movement to phase 2 recovery and/or postanesthesia care unit bypass [13]
6.	Earlier participation in physical therapy [10]
7.	Improved patient satisfaction [2]

CLINICAL EFFICACY OF PNB

PNB VS OPIOIDS.

The efficacy of sPNB in improving short-term pain control has been shown in a number of upper and lower extremity surgical procedures. In a Cochrane review of randomized trials in patients undergoing major knee surgery, PNB used in combination with systemic analgesics (primarily opioids) was associated with significantly lower pain scores at rest from 0 to 72 hours after surgery, but no difference in pain on movement until 48 to 72 hours postoperatively, compared with systemic analgesics alone [6]. This review included a broad range of surgical procedures (TKA, anterior cruciate ligament [ACL] repair, and meniscectomy), block techniques (sPNB and cPNB), and locations (femoral, femoral/sciatic, adductor canal), many of which have been investigated in more focused systematic reviews. A meta-analysis of randomized trials comparing single-shot FNB to intravenous patient-controlled analgesia opioids showed a significant reduction in pain at rest and on movement for up to 24 and 48 hours, respectively, with significantly less opioid consumption for up to 48 hours [2]. When continuous FNB was compared with intravenous patient-controlled analgesia, pain at rest and pain on movement were significantly reduced for 48 and 72 hours, respectively [2]. In a meta-analysis comparing single and continuous psoas compartment block to oral opiates in patients undergoing total hip arthroplasty, visual analogue scale pain scores was significantly reduced in patients receiving either type of psoas compartment block at up to 24 hours postoperatively [3]. The impact of PNB on pain intensity in patients undergoing ACL repair is not as clear. In a Cochrane review comparing PNB in combination with systemic analgesia to systemic analgesia alone (n = 3 randomized controlled trials), pain intensities at rest and on movement were not significantly improved in patients undergoing ACL repair receiving PNB [6]. In a systematic review of 13 randomized trials comparing FNB to sham or placebo blocks in patients undergoing ACL surgery, Mall and Wright [17] found that pain relief was greater with FNB in only 5 trials and that opioid-related nausea and sedation occurred less frequently in the FNB group in only 1 trial. Differences in study designs and outcomes have largely prevented studies of upper extremity surgical procedures to be combined using meta-analysis [4]; however, several systematic reviews have provided qualitative summaries of the existing evidence. In a review of trials comparing single-shot and continuous interscalene block (ISB) to saline injection or opioids for shoulder surgery, pain control was superior with single-shot ISB for up to 24 hours in 4 of 4 trials and with continuous ISB for up to 48 hours in 2 of 2 trials [18]. A more recent review focusing on arthroscopic shoulder surgery reported

that all of the 10 studies included found significant reductions in pain for up to 24 hours after surgery, with significant reductions in opioid use seen in 8 of 9 studies reporting this outcome [7].

RISKS AND LIMITATIONS OF PNB

Potential risks of PNB, regardless of technique or block location, include vascular puncture and bleeding, nerve damage, and local anesthetic systemic toxicity (LAST). PNB placement using ultrasound guidance has been shown to reduce the incidence of vascular puncture [23]. Neurologic complications are of particular concern because the duration of symptoms can extend for weeks or months after surgery [24,25]. These events are typically described by patients as tingling, pain on pressure, or pins and needles, and are associated with both sPNB and cPNB [24]. The incidence has been reported to be as high as 8.2% [26], with mixed evidence regarding the relative risk with sPNB vs cPNB. One study showed a higher incidence with sPNB vs cPNB in patients receiving femoral blocks [24] and one showed higher rates of neurological complications lasting at least 6 months with cPNB, although this difference did not reach statistical significance ($P = .08$) [27]. Signs and symptoms of LAST are dose dependent and range from metallic taste, tinnitus, and perioral numbness to seizure, cardiac arrest, and death [28]. Registry-based studies that included either exclusively or primarily sPNB have reported seizure incidence of 0.08 to 0.28 case per 1000 blocks [27,29,30], whereas studies evaluating exclusively cPNB have found no cases of seizure [25,31]. Because of significant overlap in the range of incidence, it is difficult to determine whether seizure risk is reduced with cPNB. Retrospective studies have found no increased risk of falls in patients undergoing TKA with PNB [16,32,33]. However, in a pooled analysis of 3 randomized, placebo-controlled trials, patients with lower extremity cPNB with ropivacaine had significantly more falls than patients receiving perineural saline (7% vs 0%; $P = .013$) [34]. In a meta-analysis of 5 studies comparing fall risk among patients receiving lumbar plexus (either femoral or psoas) cPNB to sPNB or no PNB, cPNB was associated with a nearly 4-fold increase in the risk of falls [35]. Single-shot FNB was not associated with an increased risk of fall. Adductor canal blocks are associated with less quadriceps weakness [37-39], greater ability to ambulate [40,41], and similar pain control compared with FNB in patients undergoing TKA [37-41]; however, it is not yet clear whether these differences directly impact fall risk. Upper extremity PNBs may be complicated by pleural puncture and central neuraxial needle placement [18]. Pneumothorax has been recently reported in 0.2% of patients receiving continuous ISB [42]. In a systematic review of 13 prospective and retrospective studies in patients receiving ISBs, Moore and colleagues [43] reported that adverse effects including dyspnea, hoarseness, Horner syndrome, and failed block occurred in 8.14% of patients. However, a retrospective analysis of 17 157 patients undergoing total shoulder arthroplasty found no increase in the risk of pulmonary complications or need for mechanical ventilation among patients receiving ISB in combination with general anesthesia compared with general anesthesia alone [44].

SINGLE-SHOT PNB

The major limitation of sPNB is the short duration of action of most local anesthetics. As such, sPNB is best suited for surgical procedures in which postoperative pain is not expected to exceed 12-24 hours in duration; otherwise, patients are at risk for significant rebound pain after discharge [45]. Thus, alternative methods of overcoming these limitations for surgical procedures with pain persisting past the first postoperative day are required.

CONTINUOUS PNB

The incidence of cPNB complications is highly dependent on the insertion technique and block location, and thus, it is difficult to make generalizations across studies. Minor complications include catheter dislodgement, obstruction, and fluid leakage at the catheter site [46]. Rates of catheter dislodgement in studies of volunteers engaging in activities of daily living were as high as 25% [47]. Risk factors for colonization among patients receiving ultrasound guided catheter insertion include catheter duration ≥ 48 hours, diabetes, and antibiotic administration during the month prior to surgery [48]. In contrast, single-injection PNB conducted under ultrasound guidance has not been associated with infection [49]. The costs associated with cPNB are an important consideration for providers and hospitals implementing this technique. These costs include infusion pumps, catheters, and other supplies; local anesthetic medications; and provider time required for patient education and follow-up. Sites using cPNB may realize cost savings with the use of reusable vs disposable

pumps and using fixed-rate, basal-only pumps compared with variable-rate, bolus-capable pumps [50]. Ultrasound-guided sciatic cPNB has been shown to be more cost-effective than nerve stimulation guidance for catheter placement, with an increase in equipment costs being offset by a reduction in postoperative nursing time [51]. Patients for whom ambulatory cPNB may be inappropriate include those with known renal and hepatic insufficiency [52], heart and/or lung disease [52], altered mental status or psychosocial issues [53], inability to be contacted after discharge or to access a medical facility in case of emergency [45], and unwillingness to accept responsibility for pump management [52]. Prior to discharge, patients must be educated on the appropriate care of the catheter site and dressing, when to stop the pump for signs of toxicity, how to troubleshoot any catheter or pump issues, when to call the physician or nurse for signs of infection or problems with the infusion system, and instructions for catheter removal [53,54]. Ambulatory cPNB protocols differ in the frequency and mode of contact with patients after discharge, ranging from written instructions only to home nursing visits [55], and the appropriate strategy should be determined on a case-by-case basis with consideration for the type of surgery and patient characteristics. Regardless of planned follow-up, however, a health care provider is required to be available 24 hours per day, 7 days per week to address patient concerns and questions. Catheter removal can usually be performed by the patient or a caregiver [45].

DISCUSSION

Peripheral nerve block techniques are now commonly incorporated into multimodal postoperative analgesic strategies. The consequences of expanded use of PNB include improvement in pain relief and postoperative opioid requirements, in addition to improved postoperative recovery and fewer opioid-related adverse events. As an extension of these benefits, patients are able to be discharged from the hospital earlier, and surgical procedures are able to be performed in outpatient settings. Despite these advances, there is room for improvement in the provision of postoperative pain management. Although cPNB addressed the primary limitation of sPNB, it has introduced a new set of technical difficulties, patient education needs, and complications. For carefully selected patients and well-trained anesthesiologists, cPNB can be a safe and effective postoperative pain management strategy. Unfortunately, the increased complexity associated with an indwelling catheter and pump assembly increases the likelihood of technique failure (i.e., catheter dislodgement, kinking, or leaking), and there are many patients for whom cPNB is not appropriate either because of comorbid conditions, logistical issues, or unwillingness to participate in management. Additional PNB modalities are needed to reach this population, in addition to minimizing risks of complications and costs among patients who are cPNB candidates.

REFERENCES

- Joshi GP, Schug SA, Kehlet H. Procedure-specific pain management and outcome strategies. *Best Pract Res Clin Anaesthesiol* 2014;28:191-201.
- Chan EY, Fransen M, Parker DA, Assam PN, Chua N. Femoral nerve blocks for acute postoperative pain after knee replacement surgery. *Cochrane Database Syst Rev* 2014;5:CD009941.
- Touray ST, de Leeuw MA, Zuurmond WW, Perez RS. Psoas compartment block for lower extremity surgery: a meta-analysis. *Br J Anaesth* 2008;101:750-60.
- Ullah H, Samad K, Khan FA. Continuous interscalene brachial plexus block versus paretal analgesia for postoperative pain relief after major shoulder surgery. *Cochrane Database Syst Rev* 2014;2:CD007080.
- Fredrickson MJ, Ball CM, Dalgleish AJ. Analgesic effectiveness of a continuous versus single-injection interscalene block for minor arthroscopic shoulder surgery. *Reg Anesth Pain Med* 2010;35:28-33.
- Xu J, Chen XM, Ma CK, Wang XR. Peripheral nerve blocks for postoperative pain after major knee surgery. *Cochrane Database Syst Rev* 2014; 12:CD010937.
- Hughes MS, Matava MJ, Wright RW, Brophy RH, Smith MV. Interscalene brachial plexus block for arthroscopic shoulder surgery: a systematic review. *J Bone Joint Surg Am* 2013;95:1318-24.
- Bates C, Laciak R, Southwick A, Bishoff J. Overprescription of postoperative narcotics: a look at postoperative pain medication delivery, consumption and disposal in urological practice. *J Urol* 2011;185:551-5.
- Rodgers J, Cunningham K, Fitzgerald K, Finnerty E. Opioid consumption following outpatient upper extremity surgery. *J Hand Surg Am* 2012;37:645-50.
- Liu Q, Chelly JE, Williams JP, Gold MS. Impact of peripheral nerve block with low dose local anesthetics on analgesia and functional outcomes following total knee arthroplasty: a retrospective study. *Pain Med* 2014.
- Lenart MJ, Wong K, Gupta RK, Mercedo ND, Schilderout JS, Michaels D, et al. The impact of peripheral nerve techniques on hospital stay following major orthopedic surgery. *Pain Med* 2012;13:828-34. [12] Chan EY, Fransen M, Sathappan S, Chua NH, Chan YH, Chua N. Comparing the analgesia effects of single-injection and continuous femoral nerve blocks with patient controlled analgesia after total knee arthroplasty. *J Arthroplasty* 2013;28:608-13.
- Williams BA, Kentor ML, Vogt MT, Vogt WB, Coley KC, Williams JP, et al. Economics of nerve block pain management after anterior cruciate ligament reconstruction: potential hospital cost savings via associated postanesthesia care unit bypass and same-day discharge. *Anesthesiology* 2004;100:697-706.
- Srikumaran U, Stein BE, Tan EW, Freehill MT, Wilckens JH. Upperextremity peripheral nerve blocks in the perioperative pain management of orthopaedic patients: AAOS exhibit selection. *J Bone Joint Surg Am* 2013;95 e197(1-13).

- [15] Stein BE, Srikumar U, Tan EW, Freehill MT, Wilckens JH. Lower extremity peripheral nerve blocks in the perioperative pain management of orthopaedic patients: AAOS exhibit selection. *J Bone Joint Surg Am* 2012;94:e167.
- [16] Lovald S, Ong K, Lau E, Joshi G, Kurtz S, Malkani A. A comparison of complications associated with catheter and injection femoral nerve blocks in knee arthroplasty. *J Arthroplasty* 2016 [In press].
- [17] Mall NA, Wright RW. Femoral nerve block use in anterior cruciate ligament reconstruction surgery. *Arthroscopy* 2010;26:404-16.
- [18] Fredrickson MJ, Krishnan S, Chen CY. Postoperative analgesia for shoulder surgery: a critical appraisal and review of current techniques. *Anaesthesia* 2010;65:608-24.
- [19] Bingham AE, Fu R, Horn JL, Abrahams MS. Continuous peripheral nerve block compared with single-injection peripheral nerve block: a systematic review and meta-analysis of randomized controlled trials. *Reg Anesth Pain Med* 2012;37:583-94.
- [20] Ilfeld BM, Mariano ER, Girard PJ, Loland VJ, Meyer RS, Donovan JF, et al. A multicenter, randomized, triple-masked, placebo-controlled trial of the effect of ambulatory continuous femoral nerve blocks on discharge-readiness following total knee arthroplasty in patients on general orthopaedic wards. *Pain* 2010;150:477-84.
- [21] Ilfeld BM, Ball ST, Gearen PF, Le LT, Mariano ER, Vandenborne K, et al. Ambulatory continuous posterior lumbar plexus nerve blocks after hip arthroplasty: a dual-center, randomized, triple-masked, placebo-controlled trial. *Anesthesiology* 2008;109:491-501.
- [22] Ilfeld BM, Vandenborne K, Duncan PW, Sessler DI, Enneking FK, Shuster JJ, et al. Ambulatory continuous interscalene nerve blocks decrease the time to discharge readiness after total shoulder arthroplasty: a randomized, triple-masked, placebo-controlled study. *Anesthesiology* 2006;105:999-1007.
- [23] Abrahams MS, Aziz MF, Fu RF, Horn JL. Ultrasound guidance compared with electrical neurostimulation for peripheral nerve block: a systematic review and meta-analysis of randomized controlled trials. *Br J Anaesth* 2009;102:408-17.
- [24] Widmer B, Lustig S, Scholes CJ, Molloy A, Leo SP, Coolican MR, et al. Incidence and severity of complications due to femoral nerve blocks performed for knee surgery. *Knee* 2013;20:181-5.
- [25] Compere V, Rey N, Baert O, Ouennich A, Fourdrinier V, Roussignol X, et al. Major complications after 400 continuous popliteal sciatic nerve blocks for post-operative analgesia. *Acta Anaesthesiol Scand* 2009;53: 339-45.
- [26] Fredrickson MJ, Kilfoyle DH. Neurological complication analysis of 1000 ultrasound guided peripheral nerve blocks for elective orthopaedic surgery: a prospective study. *Anaesthesia* 2009;64:836-44.
- [27] Sites BD, Taenzer AH, Herrick MD, Gilloon C, Antonakakis J, Richins J, et al. Incidence of local anesthetic systemic toxicity and postoperative neurologic symptoms associated with 12,668 ultrasound-guided nerve blocks: an analysis from a prospective clinical registry. *Reg Anesth Pain Med* 2012;37:478-82.
- [28] Morau D, Ahern S. Management of local anesthetic toxicity. *Int Anesthesiol Clin* 2010;48:117-40.
- [29] Auroy Y, Benhamou D, Bagues L, Ecoffey C, Falissard B, Mercier FJ, et al. Major complications of regional anesthesia in France: the SOS regional anesthesia hotline service. *Anesthesiology* 2002;97:1274-80.
- [30] Barrington MJ, Watts SA, Gledhill SR, Thomas RD, Said SA, Snyder GL, et al. Preliminary results of the Australasian Regional Anaesthesia Collaboration: a prospective audit of more than 7000 peripheral nerve and plexus blocks for neurologic and other complications. *Reg Anesth Pain Med* 2009;34:534-41.
- [31] Nye ZB, Horn JL, Crittenden W, Abrahams MS, Aziz MF. Ambulatory continuous posterior lumbar plexus blocks following hip arthroscopy: a review of 213 cases. *J Clin Anesth* 2013;25:268-74.
- [32] Memsoudis SG, Danninger T, Rasul R, Poeran J, Gerner P, Stundner O, et al. Inpatient falls after total knee arthroplasty: the role of anesthesia type and peripheral nerve blocks. *Anesthesiology* 2014;120:551-63.
- [33] Sharma S, Iorio R, Specht LM, Davies-Lepie S, Healy WL. Complications of femoral nerve block for total knee arthroplasty. *Clin Orthop Relat Res* 2010;468:135-40.
- [34] Ilfeld BM, Duke KB, Donohue MC. The association between lower extremity continuous peripheral nerve blocks and patient falls after knee and hip arthroplasty. *Anesth Analg* 2010;111:1552-4.
- [35] Johnson RL, Kopp SL, Hebl JR, Erwin PJ, Mantilla CB. Falls and major orthopaedic surgery with peripheral nerve blockade: a systematic review and meta-analysis. *Br J Anaesth* 2013;110:518-28.
- [36] Wasserstein D, Farlinger C, Brull R, Mahomed N, Gandhi R. Advanced age, obesity and continuous femoral nerve blockade are independent risk factors for inpatient falls after primary total knee arthroplasty. *J Arthroplasty* 2013;28:1121-4.
- [37] Kwofie MK, Shastri UD, Gadsden JC, Sinha SK, Abrams JH, Xu D, et al. The effects of ultrasound-guided adductor canal block versus femoral nerve block on quadriceps strength and fall risk: a blinded, randomized trial of volunteers. *Reg Anesth Pain Med* 2013;38:321-5.
- [38] Jaeger P, Zaric D, Fomsgaard JS, Hilsted KL, Bjerregaard J, Gym J, et al. Adductor canal block versus femoral nerve block for analgesia after total knee arthroplasty: a randomized, double-blind study. *Reg Anesth Pain Med* 2013;38:526-32.
- [39] Kim DH, Lin Y, Goytizolo EA, Kahn RL, Maalouf DB, Manohar A, et al. Adductor canal block versus femoral nerve block for total knee arthroplasty: a prospective, randomized, controlled trial. *Anesthesiology* 2014;120:540-50.
- [40] Shah NA, Jain NP. Is continuous adductor canal block better than continuous femoral nerve block after total knee arthroplasty? Effect on ambulation ability, early functional recovery and pain control: a randomized controlled trial. *J Arthroplasty* 2014;29:2224-9.
- [41] Machi AT, Sztain JF, Kormylo NJ, Madison SJ, Abramson WB, Monahan AM, et al. Discharge readiness after tricompartiment knee arthroplasty: adductor canal versus femoral continuous nerve blocks—a dual-center, randomized trial. *Anesthesiology* 2015;123:444-56.
- [42] Marhofer P, Anderl W, Heuberger P, Fritz M, Kimberger O, Marhofer D, et al. A retrospective analysis of 509 consecutive interscalene catheter insertions for ambulatory surgery. *Anaesthesia* 2015;70:41-6.
- [43] Moore DD, Maerz T, Anderson K. Shoulder surgeons' perceptions of interscalene nerve blocks and a review of complications rates in the literature. *Phys Sportsmed* 2013;41:77-84.
- [44] Stundner O, Rasul R, Chiu YL, Sun X, Mazumdar M, Brummett CM, et al. Peripheral nerve blocks in shoulder arthroplasty: how do they influence complications and length of stay? *Clin Orthop Relat Res* 2014;472: 1482-8.
- [45] Salinas FV, Joseph RS. Peripheral nerve blocks for ambulatory surgery. *Anesthesiol Clin* 2014;32:341-55.
- [46] Ilfeld BM. Continuous peripheral nerve blocks: a review of the published evidence. *Anesth Analg* 2011;113:904-25.
- [47] Marhofer D, Marhofer P, Triffiterer L, Leonhardt M, Weber M, Zeitlinger M. Dislocation rates of perineural catheters: a volunteer study. *Br J Anaesth* 2013;111:800-6.
- [48] Aveline C, Le Hetet H, Le Roux A, Vautier P, Gautier JF, Cognet F, et al. Perineural ultrasound-guided catheter bacterial colonization: a prospective evaluation in 747 cases. *Reg Anesth Pain Med* 2011;36:579-84.
- [49] Alakkad H, Naeeni A, Chan VW, Abbas S, Oh J, Ami N, et al. Infection related to ultrasound-guided single-injection peripheral nerve blockade: a decade of experience at Toronto Western Hospital. *Reg Anesth Pain Med* 2015;40:82-4.
- [50] Swenson JD, Davis JJ. Getting the best value for consumable supplies in regional anesthesia. *Int Anesthesiol Clin* 2011;49:94-103.
- [51] Ehlers L, Jensen JM, Bendtsen TF. Cost-effectiveness of ultrasound vs nerve stimulation guidance for continuous sciatic nerve block. *Br J Anaesth* 2012;109:804-8.
- [52] Aguirre J, Del Moral A, Cobo I, Borgeat A, Blumenthal S. The role of continuous peripheral nerve blocks. *Anesthesiol Res Pract* 2012;2012:560879.
- [53] Greengrass RA, Nielsen KC. Management of peripheral nerve block catheters at home. *Int Anesthesiol Clin* 2005;43:79-87.
- [54] Swenson JD, Cheng GS, Axelrod DA, Davis JJ. Ambulatory anesthesia and regional catheters: when and how. *Anesthesiol Clin* 2010;28: 267-80.
- [55] McGraw RP III, Ilfeld BM. Toward outpatient arthroplasty: accelerating discharge with ambulatory continuous peripheral nerve blocks. *Int Anesthesiol Clin* 2012;50:111-25.